1970

ANNUAL REPORT

of

HOP AND MINT INVESTIGATIONS
(CRIS WORK UNIT 0650-05-02)

by

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Plant Science Research Division
Agricultural Research Service
United States Department of Agriculture

in cooperation with the

Washington Agricultural Experiment Station
Irrigated Agriculture Research and Extension Center
Prosser, Washington

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INTRODUCTION

This 1970 annual report is the first on hop investigations submitted by the Research Plant Physiologist from the Irrigated Agriculture Research and Extension Center at Prosser, Washington. The Research Plant Physiologist was transferred from the regional Hop and Mint Investigations at Corvallis, Oregon to Prosser, Washington effective March 8, 1970. Able field assistance was provided by the temporary appointment of Mr. William D. Morris, Biological Aide, effective July 1. A part-time appointment of Mrs. Patricia J. Roberts in October provided adequate secretarial assistance.

The action and results reported herein deal primarily with the evaluation and advancement of experimental hop genotypes in cooperation with the regional Hop and Mint Investigations program at Corvallis, Oregon.

This is a progress report of cooperative investigations involving Washington State personnel at the Irrigated Agriculture Research and Extension Center at Prosser and Oregon State personnel working with Hop and Mint Investigations researchers at the regional headquarters in Corvallis, Oregon. The interpretation of data contained herein may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or any statements herein should not be made without prior written approval of the Plant Science Research Division, ARS, U. S. Department of Agriculture and the cooperating agency or agencies concerned.

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USDA and Oregon State University Cooperation

Through the cooperative efforts of Dr. C. E. Horner, A. Haunold and S. T. Likens at Corvallis, the program at Prosser was furnished: a) hop germplasm for breeding, evaluation and development, b) downy mildew and Verticillium screening of advanced genotypes, c) chemical analyses of samples and other male and female genotypes, d) morphological data and mounted botanical speciments prepared by Miss Nickerson, and e) numerous

supplies and items of equipment necessary for establishing a program at Prosser.

Washington State University Cooperation

Dr. J. L. Allison, Superintendent of the Irrigated Agriculture Research and Extension Center provided necessary space for growth chambers, office and laboratory along with the labor and supplies required for remodeling the space to meet the needs of the hop program. Dr. Skotland and H. Melouk provided virus data on two advanced hop lines adapted to the hop growing area in Washington. Mr. C. E. Nelson conducted the yield trial and provided data on the performance of experimental hop line 56013 grown under different levels of N and at two different spacings.

Hop investigations were limited to a small hop yard constructed twenty years ago on the Roza Unit near the Center. Hop harvesting equipment and a drying facility was shared with three Washington State researchers experimenting with hops.

The following equipment was purchased by the Hop and Mint Investigations at Prosser:

a) 5-foot disk
b) tractor, obtained through a lease agreement
c) hydraulic spray tank
d) hydraulic crows-nest
e) hydraulic hop press
f) walk-in cooler

The above mentioned equipment was necessary for the cultural and harvest operations required in the field evaluation of varietal development. This phase of the operation, plus organizational efforts, constituted a full-time program during 1970 whereas in the future the Research Plant Physiologist plans to allocate less than 30% of his time with the hop variety improvement program. Pending the development of a field technician, the goal of 30% should be reached in 1972-73.

Foreign Visitors During 1970

1. Mr. J. Humphrey Nott, Worcestershire, ENGLAND
   West Midlands hop grower travelling via a Nuffield Scholarship visited the hop program at Prosser during late April and again during late May for a two week period. Mr. Nott's father initiated a with-in varietal hop selection program 20 years ago and is noted for the sale of propagules from his selected hop stock. The Nott farm was visited by Dr. S. N. Brooks in 1961. Mr. Nott filed a report titled "Hop Production in North America".

2. Mr. Peter Walker, Worcestershire, ENGLAND
Student at Wye College and Hop Research Department visited the hop program at Prosser the first week in September. Mr. Walker is a partner in a 75 acre West Midland hop garden established with Northern Brewer, Bullion, Wye Northdown and Wye Challenger hop varieties, all of which have a high-alpha content.

3. Dr. Daiki Murayama, Hokkaido University, Sapporo, JAPAN
Professor in plant pathology visited with Dr. Skotland and me during the first week in August. Prof. Murayama has had several graduate students working on hops. He is attempting to develop a virus program on hops similar to Dr. Skotland's.

4. Dr. & Mrs. R. Roborgh, Nelson, NEW ZEALAND
Professor in agronomy and plant breeding visited with Dr. Skotland and me during a week period in June. Dr. Roborgh is near retirement and has developed several hop varieties for New Zealand. He has a keen interest in the growth and flowering of hops in relation to daylength. His success in hop breeding is based on the proper selection of male and female parents. The triploid program was abandoned in New Zealand because it introduced disease susceptibility into otherwise resistant commercial varieties, it retained the undesirable cone morphology present in the seeded cones, it delayed maturity, and it resulted in genotypes with "top-crop" type production.

Dr. Edward Segel, Technical Director of U. S. Brewers Association, and the Hop Research Subcommittee members of U. S. Brewers Association visited the Research Center during September. Dr. Cone and I conducted an informal-type seminar with the group on the following subjects:

a) Two-spotted mite morphology and control
b) Virus screen of new genotypes
c) Developing virus-free varieties with heat treatment
d) Varietal development through breeding
e) Lupulin analysis and interpretation

1970 Growing Season

The following table includes weather data on the temperature and rainfall during the 1970 growing season. Daytime temperatures are usually 2 to 5 degrees higher and night temperatures 2 to 3 degrees lower at the experimental hop yard located five miles north of the official weather station. Fifty mile an hour winds on September 12 were followed by a frost which was detremental to commercial hop production and responsible for a complete loss of yield and chemical data from one-half our experimental lines.

Photoperiodic tables are included as a source of data for future studies. Hops are classified as "short-day" plants, requiring approximately a 14 hour day for floral induction. Generally hops genotypes flower later in Washington than in Oregon.

New hop plantings in the Yakima Valley are established during February when moisture conditions are optimum. The late transfer to Prosser required establishing plantings in March with low soil moisture resulting in numerous losses. Old established plantings started to elongate after March 15, were pruned during April 1 to 21, and trained shortly after May 1 until the end of May. Plots were irrigated every 10 to 14 days after April 15.

April day temperatures were cool and included several "hard" frosts up to April 27. The first week in May had day temperatures in the mid-80's followed by 60 degree days and freezing nights for one week. This 30-degree hot-cool cycling also occured during a similar period in June. The later part of May was warm. Freezing night temperatures on May 10-11 required re-training of many hop yards.

Hot-cool-hot temperature cycle in May and June promoted the expression of Prunus necrotic ringspot virus (PNRSV). Mottling was displayed immediately following the cool period, depending on the variety and stage of growth, mottling was followed by ringspots and necrosis within two weeks. Temperature conditions in May resulted in a lower vine-leaf expression of PNRSV, since vines were only 4 to 8 feet in length. The PNRSV expression in June was displayed on floral buds and described as "fluffy-tip". This condition has been noted in Cluster hops during the past ten years and thought to be responsible for the majority of yield reduction associated with the Cluster variety. Dr. Skotland's "virus-free" Cluster lines have been available for ten years, but constitute less than half the Washington acreage. The yield loss in 1970 has promoted the planting of a large acreage to "virus-free" stock in 1971.

Data on Weather During the Hop Growing Season at Prosser, Washington, 1970

The weather station is located 5 miles northeast of Prosser, at IAREC, latitude 46°15'N, longitude 119°45'W, and 840 feet above sea level. The climate is characterized by low percipitation, warm summers with low humidity, high evaporation rate (37 inches from April to October), clear days during the summer, a frost-free period which averages 160 days, and windy periods during the spring.

Maximum and minimum temperatures in degrees Fahrenheit for each day during March through September, 1970

	Mar '70		Apr '70		May '70		June '70		July '70		Aug '70		Sept '70	
Date	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	40	28	61	36	68	37	80	47	74	46	85	50	87	50
2	34	24	67	31	74	40	89	51	82	53	79	50	85	42
3	42	28	59	27	84	43	94	58	91	52	81	51	82	54
4	44	29	62	42	81	45	99	54	99	62	86	52	70	44
5	48	28	64	43	81	43	88	52	100	58	93	50	70	44
6	49	34	69	45	73	38	93	56	94	50	90	52	70	50
7	55	43	63	30	66	36	98	53	91	54	91	48	75	54
8	54	27	53	31	68	44	85	48	97	55	90	43	76	41
9	55	26	64	44	60	40	67	49	100	57	79	45	69	36
10	54	28	63	35	62	30	69	37	98	54	83	45	73	38
11	56	30	58	39	58	30	71	44	95	52	89	51	81	46
12	55	31	57	25	64	43	71	43	92	60	87	54	67	45
13	51	34	55	34	59	34	75	51	88	55	94	52	58	36
14	60	41	60	43	65	36	73	53	87	50	83	45	59	36
15	60	34	59	32	74	43	71	53	92	53	84	44	64	32
16	77	44	59	29	83	49	74	48	93	58	90	54	70	42
17	58	31	60	29	83	48	69	38	98	49	89	42	73	58
18	57	28	63	35	74	42	82	49	91	52	82	45	77	55
19	56	24	59	40	76	44	93	54	96	60	84	45	71	40
20	58	29	52	36	76	41	95	55	100	55	88	49	70	43
21	63	29	54	31	74	44	95	64	92	50	87	49	67	37
22	58	28	57	36	79	52	101	61	86	44	91	50	71	46
23	59	38	64	35	76	40	99	57	80	46	96	60	71	36
24	62	33	60	45	76	44	98	56	87	50	98	60	63	33
25	60	29	59	36	81	47	95	52	84	60	95	49	63	30
26	63	42	54	28	88	52	99	66	80	55	87	43	65	36
27	62	31	52	25	74	47	98	60	85	58	85	47	72	41
28	69	37	57	36	72	37	78	53	81	44	87	48	77	41
29	62	41	65	33	68	44	72	41	78	44	83	47	80	43
30	57	38	63	35	78	40	70	38	78	46	80	48	82	44
31	59	34			27	42			78	45	88	52		
1970 Av	57	32	60	35	73	42	82	51	89	52	87	47	72	42
Norm AV	56	32	66	37	74	44	80	49	88	53	86	52	78	47

Percipitation in inches by months, 1970

	Mar	Apr	May	June	July	Aug	Sept
1970	0.21	0.36	0.26	0.15	0.09	0.00	0.15
Norm	0.54	0.54	0.58	0.68	0.17	0.20	0.37

Photoperiodic Daylengths at 45° North Latitude as Determined by Normal Sunrise and Sunset.

APRIL	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30
Sunrise	0539	0534	0528	0523	0518	0512	0507	0502	0457	0453
Sunset	1829	1832	1836	1840	1844	1848	1851	1855	1859	1903
Interval (hrs)	12h50'	12h58'	13h08'	13h17'	13h26'	13h36'	13h44'	13h53'	14h02'	14h10'

MAY	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-31
Sunrise	0448	0444	0440	0436	0432	0429	0426	0423	0421	0417
Sunset	1906	1910	1914	1917	1921	1924	1928	1931	1934	1938
Interval (hrs)	14h18'	14h26'	14h34'	14h41'	14h49'	14h55'	15h02'	15h08'	15h13'	15h21'

JUNE	1-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-30
Sunrise	0416	0415	0414	0413	0413	0413	0413	0413	0414	0416
Sunset	1940	1942	1944	1946	1947	1949	1950	1950	1951	1950
Interval (hrs)	15h24'	15h27'	15h30'	15h33'	15h34'	15h36'	15h37'	15h37'	15h37'	15h34'

JULY	1-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	26-26	27-31
Sunrise	0417	0419	0421	0423	0425	0428	0431	0434	0437	0442
Sunset	1950	1950	1949	1947	1945	1943	1941	1938	1935	1931
Interval (hrs)	15h33'	15h31'	15h28'	15h26'	15h20'	15h15'	15h10'	15h04'	14h58'	14h48'

AUGUST	1-4	5-7	8-10	11-13	14-16	17-19	20-22	23-25	26-28	29-31
Sunrise	0446	0451	0454	0458	0501	0505	0508	0512	0515	0519
Sunset	1925	1920	1916	1912	1907	1902	1857	1852	1847	1841
Interval (hrs)	14h39'	14h29'	14h22'	14h14'	14h06'	13h57'	13h49'	13h40'	13h32'	13h22'

SEPTEMBER	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30
Sunrise	0523	0526	0530	0533	0537	0541	0544	0548	0551	0555
Sunset	1836	1830	1825	1819	1813	1808	1802	1756	1751	1745
Interval (hrs)	13h13'	13h04'	12h55'	12h46'	12h36'	12h27'	12h18'	12h08'	12h00'	11h50'

Data obtained from the 1969 Nautical Almanac published by the U. S. Naval Observatory

Photoperiodic Daylengths at 45° North Latitude as Determined by the Period of Civil Twilight 1/ Before Sunrise and After Sunset.

APRIL	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-31
Sunrise	0510	0504	0458	0453	0447	0442	0436	0431	0426	0421
Sunset	1858	1902	1906	1910	1914	1919	1923	1927	1931	1935
Interval (hrs)	13h48'	13h58'	14h08'	14h17'	14h27'	14h37'	14h47'	14h56'	15h05'	15h14'

MAY	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-31
Sunrise	0416	0411	0407	0402	0358	0355	0351	0348	0345	0341
Sunset	1939	1943	1947	1951	1955	1959	2002	2006	2009	2015
Interval (hrs)	15h23'	15h32'	15h40'	15h49'	15h57'	16h04'	16h11'	16h18'	16h24'	16h34'

JUNE	1-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-30
Sunrise	0340	0339	0337	0336	0335	0335	0335	0336	0337	0339
Sunset	2016	2018	2021	2023	2025	2026	2027	2028	2028	2027
Interval (hrs)	16h36'	16h39'	16h44'	16h47'	16h50'	16h51'	16h52'	16h52'	16h51'	16h48'

JULY	1-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-31
Sunrise	0340	0342	0344	0346	0349	0352	0355	0359	0402	0408
Sunset	2027	2027	2025	2024	2021	2019	2016	2013	2010	2004
Interval (hrs)	16h47'	16h45'	16h41'	16h38'	16h32'	16h27'	16h21'	16h14'	16h08'	15h56'

AUGUST	1-4	5-7	8-10	11-13	14-16	17-19	20-22	23-25	26-28	29-31
Sunrise	0412	0417	0421	0425	0429	0433	0437	0441	0445	0449
Sunset	2000	1953	1949	1944	1939	1934	1928	1923	1917	1912
Interval (hrs)	15h48'	15h36'	15h28'	15h19'	15h10'	15h01'	14h51'	14h42'	14h32'	14h23'

SEPTEMBER	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30
Sunrise	0452	0456	0500	0504	0507	0511	0515	0518	0522	0526
Sunset	1906	1900	1855	1849	1843	1837	1831	1825	1820	1814
Interval (hrs)	14h14'	14h04'	13h55'	13h45'	13h36'	13h26'	13h16'	13h07'	12h58'	12h48'

1/ Civil twilight is the time before sunrise and after sunset when the sun is 6° below the horizon. On a clear day the light intensity of the sun 6° below the horizon is 2 lux.

Data obtained from the 1969 Nautical Almanac published by the U. S. Naval Observatory

1970 Hop Production

U. S. hop production exceeded the 80% salable allotment by one million pounds in 1970. Eighty percent of the surplus production was in the State of Washington which also had the highest yield per acre in the U.S. Washington harvasted 6,200 and 12,400 acres of late and early Cluster hops respectively. The majority of the early Cluster acreage is planted to Dr. Skotland's E-2, E-21, and L-1 selections which are "virus-free" lines. Late Cluster hops in Washington are so-called "old lates" which displayed PNRS virus symptoms and a serious yield reduction in 1970. In 1971 E-2 and L-1 selections will replace most of the acreage previously planted to early Cluster, whereas the late Cluster will gradually be replaced with Dr. Skotland's L-8 and L-16 selections. The high yield of E-2 and L-1 was largely responsible for the high State yield in 1970. Washington also grows approximately 200 acres of Talisman hops which were affected by PNRS virus and consequently their production was reduced from previous years.

Idaho suffered a considerable yield loss during 1970. Their acreage is about one-third each of Talisman, early Cluster, and late Cluster. Weather conditions in Idaho were similar to Washington during May and June and it is possible that virus was responsible for some of the yield loss.

Oregon's yield per acre was the highest on modern record as reflected in the 2,226 pound per acre yield of seeded "English" varieties. The combined production of extract-type hop varieties Bullion, Brewers Gold in Oregon and Talisman in Idaho represented approximately 7 million pounds.

Approximately 15 million pounds of hops were extracted in the U.S. last year of which 60% were used in domestic consumption and 40% exported. Brewery consumption was 36.4 million pounds which included 11.2 million pounds of imported Continental-type hops. Imports were off-set with 18 million pound export of which one-third was extract hop equivalents.

Prior to 1960 hop extraction was absent or non-significant in the U.S., but since then domestic and foreign extracters have developed rapidly and last year extracted 40% of the salable hops in the U.S. During this period production of Continental-type hop varieties remained at 5% of the total, whereas extract-type production was increased slightly from 10% to 20% of the total and the remainder was Cluster production. Meanwhile some Europeon countries have changed from growing 100% Continental-type to extract-type varieties which accounts for more than 50% of their total production.

These recent trends in hop marketing will provide the Hop and Mint Investigations at Corvallis and Prosser with an opportunity to develop and advance extract-type hop lines and accomplish our objectives established several years ago.

HOPS: Acreage, yield, production--season average price received by growers and value--annual 1968, 1969, and 1970

State	Acreage harvested			Yield per acre			Production			Price/lb		Value	
	1968	1969	1970	1968	1969	1970	1/ 1968	1/ 1969	2/ 1970	1969	1970	1969	1970
	- (000) acres -			- pounds -			- (000) pounds -			- Cents -		-(000) dollars-	
Idaho	3.3	3.2	3.3	1,740	1,860	1,540	5,742	5,952	5,082	53.0	58.0	3,155	2,948
Washington	19.1	18.1	18.7	1,510	1,560	1,680	28,841	28,236	31,416	50.0	55.0	14,118	17,279
Oregon	4.5	4.2	4.3	1,480	1,250	1,670	6,660	5,250	7,181	52.0	58.0	2,730	4,165
California	1.5	1.5	1.4	1,660	1,550	1,560	2,490	2,325	2,184	56.0	59.0	1,302	1,289
United States	28.4	27.0	27.7	1,540	1,547	1,656	43,733	41,763	45,863	51.0	56.0	21,305	25,681

1/ Harvested production. Includes hops destroyed in kiln and warehouse fires after harvest and quantities placed in reserve under Federal Market Order 991.

2/ Total production. Quantities available for market will be governed by regulations issued under Federal Market Order 991.

Data obtained from U. S. Department of Agriculture, Consumer and Marketing Service, Hop Market News dated Dec. 30, 1970.

VARIETAL DEVELOPMENT

Introduction

Hop varietal development at Prosser is an integral part of the breeding program at Corvallis. An evaluation program initiated by Corvallis ten years ago provided Prosser with approximately 300 genotypes annually. The genotypes consisted of progeny from all crosses excluding males, dwarfs, and mildew infected lines. A single-hill nursery was grown one year and selected lines were advanced into a five-hill plot for continued evaluation.

Many of the lines sent to Prosser during this period carried a virus which developed symptoms under Washington's temperature regime. At the time it was believed that the performance of a genotype could differ between Oregon and Washington. This was demonstrated in the past, but was confounded with seeded performance in Oregon versus seedless conditions in Washington and virus infected plants which later developed symptoms in Washington.

Genotypes which perform well under seedless conditions in Oregon, in terms of cone number and size, will probably have a similar yield performance in Washington. Likewise poor yielding varieties in Oregon perform poorly under Washington conditions. Growers often discuss comparative yields of Fuggle, Bullion, or other varieties in Oregon and Washington unfairly due to differences in seed. Maturity of a variety will vary with differences in latitude or daylength, though the difference may be small between Prosser and Corvallis.

Crosses and selections made at Prosser will be preceded with the letter W; example, cross W901 or selection W901-01. Selections obtained from the program at Corvallis and evaluated at Prosser will retain the six digit number assigned by the breeder in Oregon. All accession numbers will be assigned by the regional headquarters in Corvallis.

Crossing

In 1970, Dr. Haunold provided Prosser with pollen, seed, and seedlings as part of our cooperative effort in varietal development. On August 10, pollen stored in glass vials was packaged in a thermos container and shipped by bus from Corvallis to Prosser. Three females; 62013, 64007, and 66052, which were regarded as being receptive, were pollinated on August 11 with stored pollen. Pollinated cones were harvested on 12 September, following a severe wind storm, but a good seed set was noted at this time. Hop seeds mature 40 days after fertilization; therefore, seeds obtained from the 1970 may not germinate, but the viability of stored pollen sent from Corvallis was demonstrated.

The following table lists the 1970 crosses made at Prosser and 1969 crosses (*) made by Dr. Haunold at Corvallis, Oregon.

Cross No.	Parentage	Pedigree	Progeny Selection Criterion
*6904	62013 x 19039M	1/4 UT-WA, 1/8 SU, 1/8 F, 1/8 RV, 3/8 X	Earliness; ∝
*6905	62013 x 6616-61M	1/4 BG, 1/4 UT-WA, 1/8 F, 1/8 SU, 1/8 COL-WA	Good storage; ∝
*6906	62013 x 6669-09M	1/4 BUL, 1/4 UT-WA, 1/8 SU, 3/8 X	Earliness; good storage; ∝
W001	62013 x 63012M	1/2 UT-WA, 1/4 BG, 1/8 SU, 1/8 X	∝
W002	62013 x OP	1/4 UT-WA, 1/8 SU, 5/8 X	Earliness; ∝
W003	64007 x 63012M	1/4 BG, 1/4 UT-WA, 1/8 EG, 3/32 F, 1/16 LG, 7/32 X	∝
W004	66052 x 63012M	1/2 PR, 1/4 BG, 1/4 UT-WA	∝
W005	66052 x 19039M	1/2 PR, 1/8 F, 1/8 RV, 1/4 X	Earliness; ∝

The seed from the 1969 and 1970 crosses will be field planted in 1971. Cross W002 represents open-pollinated seed obtained from a commercial planting of 62013. The three female parents are disease resistant, high yielding, and high alpha (except 64007) lines crossed onto males with a high alpha-beta ratio. The two males used in crosses 6905 and 6906 also possess a good storability property. As hop ranch acreage increases there is an increasing demand for early maturing varieties with high alpha-acid. Progeny from 62013 in previous years displayed a maturity range from three weeks earlier than to that of the female parent. Some of these selections are numbered 6806- and discussed under the section Single-Hill Nursery.

Seedling Nursery

In 1966 Mr. S. T. Likens attempted several test crosses, using high alpha males and females to determine the liklihood of obtaining progeny which exceeded their parents in α- and β-acid content. The downy mildew screening procedure with greenhouse grown seedlings was by-passed so that we could work with larger populations. Techniques and procedures for evaluating genotypic and phenotypic properties of seedlings are described in the 1967-68 Hop and Mint Investigations Annual Report under the heading Trial Crosses for High Analysis.

Dr. Haunold used a modification of this field planting technique with triploid Fuggle progeny in 1969. His success in evaluating progeny the year following a cross was repeated in another genetic study initiated in 1969 to determine the inheritance of α-acid content in lupulin of male hops.

Planting seedlings directly in the field with the postponement of downy mildew evaluation, can shorten the duration of variety development by two years. Through the cooperation of Dr. A. Haunold at Corvallis it was possible to evaluate this method in Washington under more adverse conditions of moisture and temperature.

Approximately 300 seedlings from two crosses were field planted during the first week in May. The two crosses involved Cluster as the female parent crossed with a mildew-resistant male (64032) and a tetraploid male (6668-01). The method was successful, even with the late planting date, as measured by plant growth. All plants flowered, reached the wire and developed a crown equivalent to that obtained with a rhizome cutting. Male plants were discarded prior to pollen shedding. Several seedlings displayed virus symptoms which interested Dr. Skotland from the stand-point of seed transmission.

Approximately twenty percent of the progeny was saved for further evaluation in a single-hill nursery during 1971. The following tables list the selection numbers of the progeny advanced to the single-hill nursery.

1970 Selections from Seedling Nursery at Prosser, Washington

Selection	Plot	Evaluation[1/]
65102 x 64032 (1/2 LC-1, 1/4 ZAT 2L118, 1/4 X)		
48 α 29 α		
34 β 45 β		
W901-01	-03	Late, good cluster & SA
-02	-08	Late, good cluster & SA
-03	-11	Med-Early, good SA & lupulin
-04	-13	V. Late, good cluster & SA
-05	-15	Med-Early, good cluster & cone
-06	-18	Late, good cone & lupulin
-07	-19	Med-Early, good lupulin
-08	-32	Late, good lupulin
-09	-41	Late, good cluster & lupulin
-10	-44	Med-Early
-11	-47	Med-Early
-12	-52	V. Late, good cluster & cone
-13	-56	V. Late, good cluster & cone
-14	-62	Med-Early
-15	-64	Late, good cluster
-16	-69	Late, good cone
-17	-78	Late, good cluster
-18	-79	Early
-19	-82	V. Late, good cluster
-20	-86	Early, good lupulin
-21	-89	Early, good lupulin
-22	-91	Late, good cone
-23	-98	Late, good lupulin
-24	-105	V. Late, good cone
-25	-119	Late, good cluster
-26	-128	V. Late, good cluster & cone
-27	-134	Med-Early, good cone
-28	-140	Late, good lupulin
-29	-143	Med-Early, good lupulin
65104 x 6668-01 (1/3 LC-8, 1/12 F, 1/24 EG, 1/48 EC, 25/48 X)		
48 α 4n		
31 β		
W917-01	-02	Medium, good lupulin
-02	-10	V. Late, good cone
-03	-11	Late, good cone & lupulin
-04	-21	V. Early, good lupulin
-05	-22	V. Late, good cone
-06	-25	Medium, good lupulin
-07	-39	Late, good cone
-08	-43	Medium, good cone
-09	-48	Late, good cluster & cone
-10	-50	Medium, good cone
-11	-53	Medium, good lupulin
-12	-56	Medium, good cluster & lupulin

Selection	Plot	Evaluation[1/]
W917-13	-57	Med-Late, good lupulin
-14	-59	Early, good lupulin
-15	-70	Late, good cone & lupulin
-16	-79	Late, good cone
-17	-81	Late, good lupulin
-18	-88	V. Late, good cluster
-19	-89	Late, good cone & lupulin
-20	-96	Late, good cluster & cone
-21	-97	V. Late, good cluster
-22	-101	Medium, good cone
-23	-105	Med-Late, good lupulin
-24	-108	Late, good cluster & lupulin
-25	-115	Medium, good lupulin
-26	-116	Medium, good lupulin

1/ Selection was based on one of the following factors: maturity, yield, or lupulin content. All maturities are listed as a matter of record. Late and very late maturity was considered as being detremental.

Some selections from both progeny displayed more lupulin than that of the female parent. W901 progeny varied in vine color from green to a dark red. We assumed that most of the W917 progeny were triploid types. Variation in sexual expression was similar to that described by Dr. Haunold in Fuggle triploid populations. Male plants had at least one apical female inflorescence on a flowering branch. Triploid females were very uniform in vine color, cone color and cone shape. This was also observed with triploid Fuggle, but the W917 progeny received two sets of chromosomes from the male parent, instead of the female parent as was the case with the Fuggle triploid. Uniform cone morphology may be associated with all triploid populations.

In conclusion the seedling nursery method proved to be successful under Washington conditions. Seedling crowns will have a normal or near-normal production next year in the hill-nursery, which will enable us to select potential varietal material two years after crossing. The seedling nursery method will be repeated in an attempt to apply more selection pressure in the seedling year and recognize potential varieties earlier in the advancement program.

Single-hill Nursery

The 1960 nursery established by Mr. C. E. Nelson, Washington State University, consisted of 200 progeny from the 1965 crosses made at Corvallis, Oregon. The eighteen lines retained from the nursery as two year old clones in 1970 were as follows:

6502-01	6517-47	6532-06
*6503-06	6517-50	6532-15
6503-27	*6527-01	*6535-08
6512-03	*6527-06	6536-06
6512-13	*6527-16	*6538-26
6512-27	6530-12	6538-32

Selections with an asterick (*) were discarded following the 1970 growing season. Cross 6527 was made by Mr. S. T. Likens to study the inheritance of the oil components, namely α - β selinene. The entire progeny from this cross had low α-acid, very poor vigor and displayed virus symptoms. The male parent, 60007, for this cross should be recorded for transmitting undesirable genetic properties. Selection 6535-08 displayed severe PNRSV symptoms similar to its open pollinated female parent, 63021. Bullion was the female parent of the 6512 selections which displayed green Bullion-like cupped vine leaves and high lupulin content in the cone.

Selections 6536-06 and 6538-32 have sufficient varietal potential to warrant advancement in the program. The other selections will remain in the nursery and be further evaluated during 1971. Evaluations of the two-year old selections are included in the following tables with the other selections planted during 1970 in the single-hill nursery.

The 1970 nursery was established during March with genotypes selected the previous year in Oregon. Differences in performance between the two years were recorded and believed to be related to virus expression.

EVALUATION OF SINGLE-HILL NURSERY AT PROSSER,1970

Acc/Sel	Identification: Cross	♀	♂	Pedigree	Agronomic: Yr	Mat	Vig	Yld	Cone	Chemical 1/: %α	%β	Disease	Comments	Eval	Dispos
6801-05	αHxH Bro x Sis	63006 54α 24β	63013 41α 34β	1/2 BG, 1/2 UT-WA	69	-	-	-	-	30	39	------	G. cl.	--	Wa-Nur
					70	-	-	-	-	-	-	------	-----	--	Miss
6801-25					69	L	-	-	-	52	24	------	-----	---	Wa-Nur
					70	VL	M	P	P	-	-	Svr lf-curl	P. cl, sm. cone	P	Dis
6801-30					69	L	-	-	-	50	22	------	-----	--	Wa-Nur
					70	ML	M	M	G	9.1	3.8	-----	Short SA, lt color cone, F-like cone, compact	M	Hold
6801-42					69	M	-	-	-	53	19	-----	G. cl.	--	Wa-Nur
					70	L	G	M	P	-	-	Svr lf-curl	V. loose cone	P	Dis
6801-46					69	VL	-	-	-	36	32	-----	G. cl.	--	Wa-Nur
					70	VL	VG	G	-	-	-	Lf-curl	Long SA, too late	P	Dis
6801-47					69	M	-	-	-	46	21	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6801-57					69	M	-	-	-	52	20	-----	-----	--	Wa-Nur
					70	VL	M	-	-	-	-	Crinkle lf, mosaic, lf-curl	P. SA & cl, weak SA	P	Dis
6801-60					69	ML	-	-	-	56	21	-----	G. cl.	--	Wa-Nur
					70	VL	VG	G	-	-	-	-----	G. cl.	M	Adv
6802-25	αHxL	63006 54α 24β	19005 10α 57β	1/4 BG, 1/4 LC, 1/4 UT-WA, 1/4 X	69	-	-	-	-	48	23	-----	-----	--	Wa-Nur
					70	L	M	M	M	-	-	-----	Lge bracts, bold cone, top-set, F SA	P	Hold

6802-32	∝HxL	63006 54∝ 24β	19005 10∝ 57β	1/4 BG, 1/4 LC, 1/4 UT-WA, 1/4 X	69 70	VL VL	- VG	- G	- -	39 -	39 -	----- -----	G. cl. G. cl, too late, alt. branching	-- P	Wa-Nur Hold
6802-41					69 70	M -	- -	- -	- -	48 -	29 -	----- -----	G. cl. -----	-- --	Wa-Nur Miss
6802-65					69 70	E L	- M	- P	- -	46 -	28 -	----- Terminal cone	G. cl. Intersex, VP cl & set	-- P	Wa-Nur Hold
6802-75					69 70	VL VL	- M	- P	- -	33 -	42 -	----- -----	----- Too late, P. cl.	-- P	Wa-Nur Dis
6802-77					69 70	E L	- VG	- -	- -	42 -	35 -	----- -----	G. cl. BG-type cone, P. cl.	-- M	Wa-Nur Hold
6802-83					69 **70	E M	- M	- P	- M	42 5.7	33 3.4	----- -----	G. cl. Short SA, var loose cone	-- M	Wa-Nur Hold
6802-86					69 70	M L	- VG	- P	- -	48 -	32 -	----- Lf curl & bronze	G. cl. Red vine, P. cl.	-- P	Wa-Nur Dis
6802-87					69 70	L -	- -	- -	- -	46 -	27 -	----- -----	G. cl. -----	-- --	Wa-Nur Miss
6802-89					69 **70	ML ME	- G	- -	- M-P	47 4.6	18 1.4	----- -----	----- Hard pick, lt. cone color, loose, BG - like cone	-- M	Wa-Nur Hold
6802-97					69 **70	M L	- M	- -	- M	53 6.2	23 2.6	----- Terminal cone	----- BG-type cone, l. bract, open ragged cone	-- P	Wa-Nur Hold

6802-100	∝HxL	63006 54∝ 24β	19005 10∝ 57β	1/4 BG, 1/4 LC, 1/4 UT-WA, 1/4 X	69 70	M L	- M	- -	- -	48 -	27 -	----- Terminal cone	G. cl. P. cl,)10% flw♂	-- P	Wa-Nur Dis
6802-107					69 70	ML VL	- VG	- -	- -	44 -	35 -	----- -----	G. cl. G. cl.	-- M	Wa-Nur Hold
6802-112					69 70	M -	- -	- -	- -	43 -	33 -	----- Svr mosaic	G. cl. Destroyed	-- --	Wa-Nur Miss
6802-118					69 70	L VL	- G	- -	- -	44 -	35 -	----- -----	G. cl. Var. bloom, top-set	-- P	Wa-Nur Hold
6802-119					69 70	L VL	- M	- -	- -	38 -	39 -	----- -----	G. cl. P. set, too late	-- P	Wa-Nur Dis
6802-131					69 70	ML -	- -	- -	- -	44 -	30 -	----- -----	----- -----	-- --	Wa-Nur Miss
6802-139					69 70	L VL	- VG	- -	- -	31 -	44 -	----- -----	G. cl. P. cl, long SA, top-set, mat = Talisman	-- P	Wa-Nur Hold
6802-148					69 70	L VL	- VG	- -	- -	50 -	19 -	----- -----	----- P. cl, lf mottle, lf curl, weak SA	-- P	Wa-Nur Dis
6802-151					69 70	L VL	- G	- -	- -	38 -	35 -	----- -----	G. cl. P. cl, too late	-- P	Wa-Nur Dis
6803-01	∝LxH	19105 6∝ 45β	63013 41∝ 34β	1/4 BG, 1/4 LG, 1/4 UT-WA, 3/16 F, 1/16 X	69 70	L L	- VG	- -	- -	34 -	37 -	----- -----	G. cl. VG cl & SA, red vine, BG-like cone	-- M	Wa-Nur Adv

6803-14	♂LxH	19105 6 ♂ 45 ♂	63013 41 ♂ 34 ♂	1/4 BG, 1/4 LG, 1/4 UT-WA, 3/16 F, 1/16 X	69 70	L -	- -	- -	- -	37 -	34 -	----- -----	G. cl. -----	-- --	Wa-Nur Miss
6803-19					69	-	-	-	-	Not sampled			G. cl, vine broken	--	Wa-Nur
					70	VL	VG	G	-	-	-	-----	Long SA, red vine	M	Hold
6803-38					69	L	-	-	-	43	27	-----	-----	--	Wa-Nur
					70	L	VG	M	-	-	-	-----	G. cl.	M	Hold
6803-45					69	L	-	-	-	40	33	-----	G. cl.	--	Wa-Nur
					70	VL	M	P	P	-	-	-----	Svr mite infest.	P	Hold
6803-46					69	M	-	-	-	49	27	-----	G. cl.	--	Wa-Nur
					70	L	G	M	-	-	-	-----	Top-set, red vine, Long SA, P. cl.	P	Hold
6803-63					69	L	-	-	-	42	29	-----	G. cl.	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6803-68					69	M	-	-	-	37	34	-----	G. cl.	--	Wa-Nur
					70	L	M	P	M	-	-	Terminal cone	Lge bracts & cone, VP cl, cock-hop	P	Hold
6803-79					69	L	-	-	-	39	37	-----	G. cl.	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-01	♂HxH	62013 53 ♂ 23 ♂	6616-35 40 ♂ 22 ♂	1/4 BG, 1/4 UT-WA, 1/8 F; 1/8 SU, 1/8 COL-WA, 1/8 X	69 **70	L VE	- M	- -	- G	50 11.3	19 3.8	----- -----	----- Cock-hops, inter-sex, short SA, over ripe, yellow lvs	-- P	Wa-Nur Hold
6806-03					69	VL	-	-	-	48	24	-----	-----	--	Wa-Nur
					70	VL	M	-	-	-	-	-----	Yellow lvs	P	Hold
6806-08					69	VL	-	-	-	52	21	-----	-----	--	Wa-Nur
					**70	L	M	P	-	9.4	3.6	-----	P. cl.	P	Hold

6806-09	∝HxH	62013 53∝ 23β	6616-35 40∝ 22β	1/4 BG, 1/4 UT-WA, 1/8 F, 1/8 SU, 1/8 COL-WA, 1/8 X	69	L	-	-	-	48	18	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-12					69	E	-	-	-	49	23	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-15					69	E	-	-	-	51	13	-----	-----	--	Wa-Nur
					70	VE	M	P	VG	-	-	Bacterial lf-spot	Lge cone, mat 8/8	P	Dis
6806-18					69	L	-	-	-	44	18	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	♂Plant destroyed	--	Miss
6806-22					69	L	-	-	-	46	20	-----	-----	--	Wa-Nur
					**70	VE	VG	G	M-G	7.3	2.3	-----	White hops, 6 lbs gr wt, G cl, over-ripe	G	Adv
6806-23					69	L	-	-	-	46	18	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-26					69	L	-	-	-	49	19	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-37					69	VL	-	-	-	55	16	-----	-----	--	Wa-Nur
					70	M	M	P	-	-	-	-----	Yellow lf, lge loose cone, P cl, G. lup.	M	Hold
6806-38					69	L	-	-	-	47	19	-----	-----	--	Wa-Nur
					70	VL	G	G	-	-	-	Rusty mottle	VG cl, V yellow lf, burned	P	Hold
6806-39					69	L	-	-	-	48	17	-----	-----	--	Wa-Nur
					70	VL	M	-	-	-	-	Rusty mottle, mosaic	Top-set, yellow lf	P	Dis

6806-40	∝HxH	62013 53∝ 23β	6616-35 40∝ 22β	1/4 BG, 1/4 UT-WA, 1/8 F, 1/8 SU, 1/8 COL-WA, 1/8 X	69	VL	-	-	-	54	18	-----	-----	--	Wa-Nur
					70	L	G	-	-	8.2	2.6	-----	Tight cone~58112, G. cl & SA, yellow lf	M	Hold
6806-47					69	L	-	-	-	43	18	-----	-----	--	Wa-Nur
					70	ML	G	-	M	-	-	-----	♂ flws, var. mat, G. cl.	P	Hold
6806-48					69	VL	-	-	-	48	19	-----	-----	--	Wa-Nur
					70	L	M	M	-	-	-	Lf curl, bottom mottle	Top-set, G. lup.	P	Hold
6806-50					69	VL	-	-	-	53	19	-----	-----	--	Wa-Nur
					70	M	VP	VP	P	-	-	Yellow lf	Dk green lvs, ♂ flw all cock-hops, deep lobing (ornamental)	VP	Dis
6806-51					69	VL	-	-	-	38	18	-----	-----	--	Wa-Nur
					70	M	M	P	P	-	-	-----	Sm. cone, yellow lf, P. cl.	P	Hold
6806-52					69	VL	-	-	-	52	13	-----	-----	--	Wa-Nur
					70	ML	G	-	VG	8.2	2.2	Inner-vein yellows	G. lup, P. cl.	P	Hold
6806-63					69	L	-	-	-	53	15	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-67					69	M	-	-	-	51	23	-----	-----	--	Wa-Nur
					70	ML	G	-	-	-	-	-----	Short SA	M	Hold
6806-68					69	VL	-	-	-	44	21	-----	-----	--	Wa-Nur
					70	VL	G	P	-	-	-	-----	P. cl.	P	Hold

6806-71	∝HxH	62013 53 ∝ 23 β	6616-35 40 ∝ 22 β	1/4 BG, 1/4 UT-WA, 1/8 F, 1/8 SU, 1/8 COLO-WA, 1/8 X	69 L	-	-	-	40	15	-----	-----	--	Wa-Nur
					70 M	M	-	-	-	-	-----	Cock-hops, yellow lf, low lup, short SA	P	Hold
6806-73					69 L	-	-	-	49	22	-----	-----	--	Wa-Nur
					**70 E	M	-	M	7.5	2.8	-----	Mat 8/18, G. lup, short SA, BG-like cone	M	Hold
6806-75					69 M	-	-	-	52	23	-----	-----	--	Wa-Nur
					70 L	M	-	P	-	-	Lf curl, terminal cone	Cock-hops, invert bracts	P	Dis
6806-78					69 VL	-	-	-	48	21	-----	-----	--	Wa-Nur
					70 -	-	-	-	-	-	-----	-----	--	Miss
6806-80					69 M	-	-	-	57	16	-----	-----	--	Wa-Nur
					70 M	G	-	G	-	-	-----	G. lup, ♂ flwrs, short SA	P	Hold
6806-81					69 L	-	-	-	45	21	-----	-----	--	Wa-Nur
					**70 VE	M	-	G	5.9	1.9	-----	Short SA, ♂ flwr	P	Hold
6806-84					69 L	-	-	-	50	19	-----	-----	--	Wa-Nur
					70 -	-	-	-	-	-	-----	-----	--	Miss
6806-86					69 M	-	-	-	49	22	-----	-----	--	Wa-Nur
					**70 M	M	P	G	5.6	2.0	-----	Exc. cone type, P. cl.	P	Hold
6806-88					69 L	-	-	-	50	17	-----	-----	--	Wa-Nur
					70 VE	P	P	-	-	-	PNRSV, Bacterial	VG lup, lf necrosos, yellow lf, E. mat due to virus	VP	Dis
6806-94					69 ML	-	-	-	51	20	-----	-----	--	Wa-Nur
					**70 E	G	-	G	5.9	2.4	-----	Short SA, ♂ flwrs	P	Hold

6806-97	∝HxH	62013 53∝ 23β	6616-35 40∝ 22β	1/4 BG, 1/4 UT-WA, 1/8 F, 1/8 SU, 1/8 COL-WA, 1/8 X	69	VL	-	-	-	50	19	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6806-98					69	VL	-	-	-	49	17	-----	-----	--	Wa-Nur
					70	L	VG	G	-	-	-	-----	G lup, yellow lf, G. cl	M	Hold
6806-99					69	M	-	-	-	53	18	-----	-----	--	Wa-Nur
					**70	L	M	-	-	12.2	3.4	-----	P. cl, yellow lf	P	Hold
6806-103					69	L	-	-	-	44	19	-----	-----	--	Wa-Nur
					70	VL	VG	G	-	-	-	-----	yellow lf, G. cl, G. SA, red vine	M	Hold
6806-112					69	L	-	-	-	47	23	-----	-----	--	Wa-Nur
					70	L	M	-	-	-	-	Lf spot, lf curl	Inner vein yellows, lf necrosis, short SA, yellow lf	P	Dis
6701-01	DM-R	65103 47∝ 38β	OP	1/2 EC, 1/2 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	M	P	P	-	-	Irreg lob, crinkle lf	F-cone, (G@ Ore) Hal aroma, short SA	P	Dis
6701-12					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6701-14					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	M	M	P	-	-	PNRSV	F-cone, (P @ Ore) G cl, Hal aroma	P	Dis
6701-24					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6701-27					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss

6701-31	DM-R	65103 47 ∝ 38 β	OP	1/2 EC, 1/2 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6701-39					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6701-44					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	M	-	-	-	-	Svr PNRSV	-----	VP	Dis
6701-54					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6701-55					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6701-60					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6701-68					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6701-111					69	-	-	-	-	-	-	-----	Low lup (genetic)	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Replanted in July M		Hold
6702-07	SM-R	65103 47 ∝ 38 β	51114 18 ∝ 50 β	1/2 EC, 1/16 LAN, 1/16 GCL, 1/16 SEM, 1/32 F, 9/32 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6703-02	∝DM-R	65103 47 ∝ 38 β	63015 54 ∝ 22 β	1/2 EC, 3/8 BG, 1/16 EKG, 1/32 BAV, 1/32 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	P	VP	-	-	-	Yellow fleck	(G @ Ore), VP cl.	VP	Dis
6703-13					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss

6703-21	∝DM-R	65103 47∝ 38β	63015 54∝ 22β	1/2 EC, 3/8 BG, 1/16 EKG, 1/32 BAV, 1/32 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	M	M	-	-	-	Lf burn	(P @ Ore) short SA, ♂flwrs	P	Hold
6703-30					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6704-01	DM-R	65102 48∝ 34β	OP	1/2 LC, 1/2 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	M	P	-	-	-	Fusarium	(G @ Ore)	P	Hold
6704-05					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6704-06					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VE	G	-	-	-	-	Fusarium	Died late July	--	Miss
6704-13					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6704-33					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	G	G	-	-	-	-----	G. cl.	M	Hold
6704-38					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	M	M	P	-	-	-	Mosaic, crinkle lf	Short SA, (M @ Ore)	P	Dis
6704-45					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	G	-	-	-	-	-----	Hal. aroma, G. cl, red vine	M	Hold
6704-52					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6704-58					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	G	G	-	-	-	-----	V small bract, genetic G. lup & SA, oddity	M	Hold

6704-63	DM-R	65102 48α 34β	OP	1/2 LC, 3/8 F, 1/8 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	M	-	-	-	-	-----	G. cl.	M	Hold
6704-93					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VE	M	P	G	-	-	Terminal cone	Mites, P. SA & cl.	P	Hold
6704-94					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6704-105					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6704-120					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6704-124					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	G	G	-	-	-	-----	Red stripe vine, VG SA & cl, (P @ Ore)	M	Hold
6704-138					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6704-158					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	M	P	-	-	-	-----	Top-set, (G @ Ore)	P	Hold
6704-164					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	E	P	P	-	-	-	Lf burn, mosaic	G. lup, P. cl.	VP	Dis
6704-167					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					** 70	ML	VG	G	G	5.5	3.3	-----	G. cl, short SA, (M @ Ore)	M	Hold
6705-07	DM-R	65102 48α 34β	19040 39α 30β	1/2 LC, 1/2 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	ME	P	P	P	-	-	Lf bronze	F-cone, P. cl & SA	VP	Dis

6705-11	DM-R	65102 48 ♂ 34 ♀	19040 39 ♂ 30 ♀	1/2 LC, 1/2 X	69 - 70 -	- -	- -	- -	- -	- -	----- -----	----- (M @ Ore)	P --	Wa-Nur Miss
6705-15					69 - 70 L	- M	- P	- P	- -	- -	----- Lf cup, Mosaic, yellows	----- No top vine lvs, many cl, var cone	P P	Wa-Nur Dis
6706-03	SM-R	65102 48 ♂ 34 ♀	51114 18 ♂ 50 ♀	1/2 LC, 1/16 LAN, 1/16 GCL, 1/16 SEM, 1/32 F, 9/32 X	69 - 70 -	- -	- -	- -	- -	- -	----- -----	----- (VG @ Ore)	P --	Wa-Nur Miss
6706-22					69 - 70 L	- MP	- P	- -	- -	- -	----- -----	----- P. cl & SA	P P	Wa-Nur Hold
6706-23					69 - 70 M	- G	- -	- P	- -	- -	----- -----	----- Weak SA, F-cone, G. cl & SA	P P	Wa-Nur Hold
6706-04	DM-R	65102 48 ♂ 34 ♀	63014 63 ♂ 17 ♀	1/2 LC, 1/4 BG, 1/4 UT-WA	69 - 70 -	- -	- -	- -	- -	- -	----- -----	----- (VG @ Ore)	P --	Wa-Nur Miss
6707-12					69 - 70 VL	- G	- G	- P	- -	- -	----- -----	Weak SA Sm cone, too late, G. cl, var. SA	-- P	Wa-Nur Dis
6708-01	DM-R	65102 48 ♂ 34 ♀	63012 54 ♂ 24 ♀	1/2 LC, 1/4 BG, 1/4 UT-WA	69 - 70 M	- -	- -	- -	- -	- -	----- Fusarium	----- Died June (G @ Ore)	-- --	Wa-Nur Miss
6709-01	DM-R	65102 48 ♂ 34 ♀	63013 41 ♂ 34 ♀	1/2 LC, 1/4 BG, 1/4 UT-WA	69 - 70 L	- VG	- G	- -	- -	- -	----- Lf burn	----- G. cl & SA, necrosis to tip, weak SA	-- P	Wa-Nur Hold

6709-08	αDM-R	65102 48 α 34 β	63013 41 α 34 β	1/2 LC, 1/4 BG, 1/4 UT-WA	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6709-10					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6709-20					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6710-01	αDM-R	65102 48 α 34 β	63015 54 α 22 β	1/2 LC, 3/8 BG, 1/16 EKG, 1/32 BAV, 1/32 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6710-19					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6710-21					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	M	P	P	G	9.6	4.8	Terminal cone, curly lf	Dk green lf, G. lup, cock-hop, invert cone, (VG @ Ore)	P	Dis
6710-23					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	VL	MP	M	P	-	-	-----	G. cl, sm. var. cone (M @ Ore)	P	Hold
6710-32					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	ML	G	G	P	-	-	-----	Var. cone, (P @ Ore)	P	Hold
6710-38					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6710-49					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	L	G	G	G	9.6	4.6	-----	G. SA & lup, dk green	G	Adv

6711-01	∝,BC	19001	63015	7/8 BG, 1/16	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
		48∝	54∝	EKG, 1/32 BAV,**	70	ML	VG	G	G	7.9	2.4	-----	G. SA, lt green		
		22β	22β	1/32 X									cone	G	Hold
6712-01	∝,BC	19001	63012	3/4 BG, 1/4 UT-	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
		48∝	54∝	WA	70	L	VP	P	P	-	-	Mosaic,	P. SA, var. cone,		
		22β	24β									PNRSV	(VG @ Ore)	VP	Dis
6712-10					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(M @ Ore)	--	Miss
6712-13					69	-	-	-	-	-	-	-----	Suscep. to aphids	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(M @ Ore)	--	Miss
6712-21					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(M @ Ore)	--	Miss
6712-25					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(M @ Ore)	--	Miss
6715-05	∝	64100	63014	1/2 BUL, 1/4	69	-	-	-	-	-	-	-----	Lup on strig	--	Wa-Nur
		48∝	63∝	BG, 1/4 UT-WA	70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
		23β	17β												
6715-11					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					**70	L	VG	G	M	7.1	2.7	Chlorosis	G. lup, BG-cone, G. cl & SA (G @ Ore)	M	Hold
6715-13					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6715-14					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss

6715-15	∝	64100	63014	1/2 BUL, 1/4	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
		48 ∝	63 ∝	BG, 1/4 UT-	**70	L	VG	G	M	13.3	4.1	-----	Brushy, BG-cone,		
		23 β	17 β	WA									(VG @ Ore)	M	Hold
6716-08	∝	64100	63013	1/2 BUL, 1/4	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
		48 ∝	41 ∝	BG, 1/4 UT-WA	70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
		23 β	34 β												
6716-13					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6716-17					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6716-28					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6717-06	∝	64100	63012	1/2 BUL, 1/4	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
		48 ∝	54 ∝	BG, 1/4 UT-WA	70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
		23 β	24 β												
6717-07					69	-	-	-	-	-	-	-----	Suscep. to aphids-		Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6717-08					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	Missing @ Ore	--	Miss
6717-11					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6717-13					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6717-15					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(VG @ Ore)	--	Miss
6717-16					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss

6717-18	♂	64100 48♂ 23♀	63012 54♂ 24♀	1/2 BuL, 1/4 BG, 1/4 UT-WA	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	ML	M	P	G	-	-	Terminal cone, curly lf	Intersex, P. cl, ♀ flwr, (G@Ore)	P	Dis
6717-21					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6717-22					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss
6717-26					69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	-	-	-	-	-	-	-----	(G @ Ore)	--	Miss
6733-02	Gen	[915] 18♂ 42♀	[904] 31♂ 52♀	1/4 F, 1/4 EG, 1/8 RV, 3/8 X	69	-	-	-	-	-	-	-----	-----	--	Wa-Nur
					70	ML	M	M	M	-	-	-----	F-like, (P@Ore)	P	Hold
6733-05					69	-	-	-	-	-	-	-----	No lup.	--	Wa-Nur
					70	L	M	P	P	-	-	Lt drop, lf necrosis	Short SA, var sm cones, (VG @ Ore)	P	Dis
6759-03	3n	21003	OP	2/3 F, 1/3 X	*69	ML	M	G	G	5.7	4.8	Split lf, lf burn	P. cl, 5000/hill	M	Wa-Nur
					70	ML	MP	P	-	-	-	Lt bronze	P. cl, spider, (P @ Ore)	P	Dis
6760-71	3n	21003	F 1-1	2/3 F, 1/3 X	*69	[illegible]	VG	VG	G	6.7	3.7	Split lf	Sm cones, no rhizomes, 9000 cones/hill	G	Wa-Nur
					70	-	-	-	-	-	-	-----	(P @ Ore)	--	Miss

6761-12	3n	21003	F 2-4	2/3 F, 1/3 X	*69	L	G	G	G	9.5	5.6	Split lf	Lge cone, G. lup, 5000 cones/hill	G	Wa-Nur
					70	L	P	P	-	-	-	-----	Short SA, (G @ Ore)	P	Hold
6761-16					*69	ML	G	VG	M	7.9	3.1	-----	14 bale/Acre, 8000 cones/hill	G	Wa-Nur
					70	L	P	P	-	-	-	-----	Short SA, top-set, (Bronze lf, G @ Ore)	MP	Hold
6761-35					*69	L	G	G	M	6.1	3.2	-----	7000 cones/hill, P. crown, no rhizomes	M	Wa-Nur
					70	-	P	-	-	-	-	Net necro-sis, split lf	Replanted in June (G @ Ore)	VP	Dis
6761-47					*69	M	M	G	G	9.4	3.0	-----	G. lup, 5000 cones/ hill	G	Wa-Nur
					70	-	-	-	-	-	-	-----	Replanted in June, (G @ Ore)	M	Hold
6761-61					*69	M	G	G	G	10.9	3.7	-----	G. storage, G. lup, 6000 cones/hill	G	Wa-Nur
					70	L	VG	-	-	-	-	-----	Replanted in June, (VG @ Ore)	G	Adv
6761-77					*69	L	G	G	M	7.2	3.4	-----	Sm. cone, 8500 cones/hill	G	Wa-Nur
					70	-	-	-	-	-	-	-----	Replanted in June, (G @ Ore)	M	Hold
6761-100					*69	L	G	G	G	8.2	3.9	Split lf	No rhizomes, hi yield, 7000 cones/hill	G	Wa-Nur
					70	L	M	P	P	-	-	-----	Sm. cone, P. cl, (F @ Ore, red vine)	P	Hold

6761-112	3n	21003	F 2-4	2/3 F, 1/3 X	*69	L	M	G	M	10.5	3.9	-----	G. lup, 6500 cones/H	G	Wa-Nur
					70	ML	M	-	P	-	-	-----	Loose cone, P. cl, (G @ Ore)	P	Hold
6761-117					*69	M	M	G	M	8.6	4.3	-----	5000 cones/H	G	Wa-Nur
					70	ME	M	M	M	-	-	-----	G. lup, long loose cone, P. cl, (G @ Ore)	M	Adv
6763-09	3n	21003	F 1-1	2/3 F, 1/3 X	*69	M	G	VG	M	9.5	5.1	-----	6000 cones/H, 14 b/AC	G	Wa-Nur
					70	L	VG	-	-	-	-	-----	G. SA, replanted June, top-set, (G @ Ore)	M	Hold
6763-10					*69	M	G	VG	M	7.7	3.3	Downy mildew	7000 cones/H, 13 b/AC	G	Wa-Nur
					70	VL	VG	-	-	-	-	-----	Too late, (G @ Ore)	P	Hold
6763-19					*69	M	VG	VG	G	5.9	3.5	Split lf	10,000 cones/H, G. cl, 14 b/AC	G	Wa-Nur
					70	L	VG	-	P	-	-	Enlarged corky stem	Loose cone, G. SA, G. cl, (G @ Ore)	P	Hold
6763-20					*69	M	M	G	M	5.6	2.6	Split lf	5000 cones/H	G	Wa-Nur
					70	VL	-	-	-	-	-	-----	Replanted June, (F @ Ore)	M	Hold
6765-04	3n	21003	19010 30 ♂ 28 ♂	3/4 F, 1/6	*69	VE	G	VG	G	6.6	2.4	Split lf	7000 cones/H, 12 b/AC	G	Wa-Nur
					70	ML	M	M	P	-	-	-----	Short SA, loose cone, (F @ Ore)	P	Hold
6765-06					*69	L	M	G	M	7.2	3.0	Split lf	5000 cones/H	G	Wa-Nur
					70	L	M	P	-	-	-	-----	P. cl, G. SA, (P @ Ore)	P	Hold

6765-31	3n	21003	19010 30∝ 28β	3/4 F, 1/6 RV, 1/12 X	*69	VE	G	VG	G	8.3	3.1	-----	6000 cones/hill 13b/Ac	G	Wa-Nur
					70	-	-	-	-	-	-	-----	Replanted July, (P @ Ore)	M	Hold
6765-34					*69	L	M	G	M	6.1	3.3	Split lf	6000 cones/hill	G	Wa-Nur
					70	L	M	-	-	-	-	Terminal cone	Short SA, (P @ Ore)	P	Hold
6769-02	3n	21003	F 1-1	2/3 F, 1/3 X	*69	ME	G	VG	G	7.8	4.1	Downy mildew	10,000 cones/hill, 17b/Ac	G	Wa-Nur
					70	L	G	-	-	-	-	-----	F. SA, one vine, (VG @ Ore)	P	Hold
6769-03					*69	ME	G	VG	G	8.4	3.7	Split lf	11,000 cones/hill, 16b/Ac	G	Wa-Nur
					70	VL	MG	P	P	-	-	-----	F. SA, hi set, sm. cone, (Hi set, P @ Ore)	P	Hold
6769-08					*69	ME	G	G	P	7.6	3.8	-----	P. crown, no rhizomes, open cone	--	--
					70	-	-	-	-	-	-	-----	(F @ Ore)	--	Miss
6769-11					*69	ML	M	G	G	5.5	5.8	Split lf	Compact cone, 255 mg	M-G	Wa-Nur
					70	L	M	P	-	-	-	Terminal cone, fusarium	P. SA, one vine dead, other with necrosis (P @ Ore)	VP	Hold
6769-31					*69	E	G	G	M	7.1	3.7	-----	14b/Ac, harvest 8/19	G	Wa-Nur
					70	L	M	P	P	-	-	Corky vine	F-loose cone, invert bracts, top set, (F @ Ore)	P	Hold

6771-19	3n	21003	19010 30 ♂ 28 ♀	3/4 F, 1/6 RV, 1/12 X	*69	ME	M	G	P	9.0	4.7	-----	15b/Ac, cone 345 mg, lrg strig	M	Wa-Nur
					70	L	M	P	P	-	-	-----	G. lup, P. cl, open cone, (P @ Ore)	P	Hold
6616-02	♂-BC	19001 49 ♂ 22 ♀	6339-09	1/2 BG, 1/4 F, 1/4 COL-WA	*69	L	G	G	G	7.8	5.8	-----	Intersex, ♂ flwrs, white hops	M-G	Wa-Nur
					70	VL	VG	G	-	-	-	-----	Brushy, suckers w/♂, G. cl, ♂ flwrs	P	Hold
6616-03					*69	L	G	M	G	10.4	5.5	-----	Var. cone	G	Wa-Nur
					70	VL	P	-	G	-	-	-----	Replant June	M	Hold
6616-04					*69	VL	M	G	G	8.3	3.4	-----	Weak SA	G	Wa-Nur
					70	VL	VG	G	P	-	-	-----	Hi cone count, sm. cone, VG cl.	P	Hold
6616-05					*69	VL	G	VG	G	9.3	5.6	Bacterial spot	10,000 cones/hill	M	Wa-Nur
					70	VL	G	M	-	-	-	-----	F. cl, G. lup	P	Hold
6616-10					*69	L	G	VG	G	4.0	4.4	-----	Intersex, 13,000 cones/hill	M	Wa-Nur
					70	L	G	G	-	-	-	-----	G. cl.	M	Hold
6616-11					*69	E	M	M	G	8.2	5.7	Dk var. lf @ top	White hops, lge cone	G	Wa-Nur
					**70	ME	M	-	M	7.4	5.4	Curly lf	Cock-hop, G. lup	P	Hold
6616-16					*69	VL	G	G	G	8.8	4.7	-----	-----	M	Wa-Nur
					70	L	G	-	P	-	-	-----	Brushy, sm. cone	P	Hold
6616-20					*69	L	M	VG	G	9.9	6.3	-----	Intersex	G	Wa-Nur
					70	L	G	G	-	-	-	Yellow fleck	G. SA & cl.	P	Hold

6616-21	∝-BC	19001 49∝ 22β	6339-09	1/2 BG, 1/4 F, 1/4 COL-WA	*69 70	M -	G -	M -	M -	7.7 -	6.9 -	Downy mildew -----	Intersex -----	M --	Wa-Nur Miss
6616-22					*69 70	E -	P -	P -	M -	9.7 -	7.3 -	Dk var. top lf -----	Cock-hops, intersex -----	M --	Wa-Nur Miss
6616-24					*69 70	VL VL	G G	G -	M -	8.5 -	6.2 -	----- Lf drop	Intersex, white hops Too late	M VP	Wa-Nur Hold
6616-25					*69 70	VL L	M M	M P	M -	9.4 -	8.8 -	Yellow fleck Lf burn, yellow fleck	∝/β =1, intersex G. lup, P. cl, lf drop	M VP	Wa-Nur Hold
6617-02	∝-BC	19001 49∝ 22β	63013 41∝ 34β	3/4 BG, 1/4 UT-WA	*69 70	L L	G M	G G	M -	11.1 -	4.7 -	----- Yellow fleck	Intersex, ♂ flwrs G. SA, G. lup	G P	Wa-Nur Hold
6618-01	∝-BC	19001 49∝ 22β	63023 51∝ 28β	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	*69 70	L L	M -	M -	M -	11.9 -	5.5 -	Slip-down -----	Dense cone Replant June	M M	Wa-Nur Hold
6618-02					*69 70	L VL	G M	G M	M -	6.9 -	11.1 -	Downy mildew Svr lf necrosis	Intersex, white hops Short SA	M VP	Wa-Nur Dis
6618-03					*69 70	E ML	M M	G -	G -	11.3 -	6.4 -	Slip-down Net necrosis, mosaic	----- G. lup	G VP	Wa-Nur Dis

6618-04	∝-BC	19001 49∝ 22β	63023 51∝ 28β	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	*69 70	L L	M -	M -	G -	9.9 -	8.0 -	Lf drop -----	G. lup Replant June	M M	Wa-Nur Hold
6618-05					*69 **70	L ML	M G	M G	G -	11.5 9.8	5.6 3.4	Downy mildew -----	White hops, sm. cone G. lup, invert bract	M M	Wa-Nur Hold
6818-08					*69 70	M L	M G	G M	G -	12.0 9.5	7.0 5.2	Yellow fleck -----	Intersex, white hops, P. SA Replant June, P. cl, G. lup	G M	Wa-Nur Hold
6618-10					*69 70	VL VL	G M	G P	M -	11.7 -	5.1 -	Downy mildew Svr lf necrosis, yellow fleck	White hops P. cl, G. lup	G P	Wa-Nur Dis
6618-12					*69 70	L -	M -	M -	M -	11.1 -	5.8 -	----- -----	----- -----	M --	Wa-Nur Miss
6618-23					*69 70	L L	M M	M P	M -	10.8 7.9	4.7 4.4	----- -----	White hops V lge bracts, P. cl	M P	Wa-Nur Hold
6619-12	∝-BC	19001 49∝ 22β	63025 47∝ 30β	3/4 BG, 3/16 F, 1/16 X	*69 70	L VL	G G	G -	G -	11.6 -	4.3 -	Downy mildew Lf curl, PNRSV, mosaic	Intersex Irreg. lobbing	G VP	Wa-Nur Dis
6620-04	∝	19001 49∝ 22β	60013 46∝ 32β	1/2 BG, 1/2 ARIZ-WA	*69 70	VL VL	G M	G -	G -	13.2 -	6.6 -	----- -----	----- Replant June	M M	Wa-Nur Hold

6620-10	♂	19001	60013	1/2 BG, 1/2	*69	VL	G	VG	M	8.9	5.3	Downy mildew	10,000 cones/hill	M	Wa-Nur
		49 ♂	46 ♂	ARIZ-WA											
		22 ♀	32 ♀		70	VL	VG	-	-	-	-	-----	(Germ pl.) too late, many cones, genetic	P	Germ-plasm
6620-11					*69	VL	M	P	M	10.0	7.5	Rust chlorosis	Intersex, ♂ flwrs	M	Wa-Nur
					70	VL	G	-	-	-	-	Rust chlorosis	Too late	P	Dis
6620-12					*69	VL	G	G	M	8.4	6.7	Yellow fleck	Weak SA	M	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6620-13					*69	VL	G	M	G	9.8	6.3	Yellow fleck	-----	G	Wa-Nur
					70	VL	VG	-	-	-	-	Rust chlorosis	Too late	P	Dis
6620-17					*69	VL	G	G	G	9.6	4.3	-----	-----	M	Wa-Nur
					70	VL	VG	-	-	-	-	-----	G. SA, too late	P	Hold
6621-01	♂, AM-R	64100	51114	1/2 BUL, 1/16	*69	E	-	-	-	-	-	-----	G. picker	M	Wa-Nur
		48 ♂	18 ♂	GCL, 1/16 SEM,	70	M	M	-	-	-	-	-----	Replant June	M	Hold
		23 ♀	50 ♀	1/16 LAN, 1/32 F, 9/32 X											
6621-09					*69	ML	-	-	-	-	-	-----	Bul-type, G. pick	M	Wa-Nur
					70	L	M	-	G	-	-	-----	P. cl, G. lup	M	Hold
6622-11	♂,AM-R	64100	19043	1/2 BUL, 1/4	*69	ML	-	-	-	-	-	-----	Weak SA, G. lup	M	Wa-Nur
		48 ♂	20 ♂	BEL-BURV, 1/8	70	ML	P	P	-	-	-	Terminal cone	P. cl, ♂ flwr	P	Dis
		23 ♀	30 ♀	F, 1/8 X											

6622-27	♂,AM-R	64100	19043	1/2 BUL, 1/4	*69	E	-	-	-	-	-	-----	Open cone	M	Wa-Nur
		48 ♂	20 ♂	BEL-BURV, 1/8	70	VE	P	P	P	-	-	-----	♂ flwr, dk green leather leaf, no SA, lup on bract tip	VP	Dis
		23 ♀	30 ♀	F, 1/8 X											
6623-05	♂,AM-R	64100	19037	1/2 BUL, 1/4	*69	M	-	-	-	-	-	-----	-----	M	Wa-Nur
		48 ♂	23 ♂	F, 1/4 X	70	M	M	-	-	-	-	Terminal cone	G. lup, replant June	P	Hold
		23 ♀	50 ♀												
6625-01	A-R	64100	OP	1/2 BUL, 1/2	*69	L	-	-	-	-	-	-----	-----	M	Wa-Nur
		48 ♂		X	70	-	-	-	-	-	-	Fusarium	Replant June, dead July	--	Miss
		23 ♀													
6628-01	A-R	19038	54066	1/8 LG, 1/8 F,	*69	ML	-	-	-	-	-	-----	F-type	M	Wa-Nur
		42 ♂	1/16 RV, 11/16		70	L	M	P	-	-	-	-----	G. cl, top-set, short SA	P	Hold
		31 ♀	X												
6635-17	♂	59008	OP	1/2 ECL, 1/2 X	*69	VL	G	-	-	-	-	-----	-----	M	Wa-Nur
		48 ♂			70	-	-	-	-	-	-	-----	-----	--	Miss
		34 ♀													
6635-25					*69	VL	-	-	-	-	-	-----	P. SA	M	Wa-Nur
					70	L	M	-	-	-	-	Lf drop	P. lup	P	Hold
6635-34					*69	VL	-	-	-	-	-	-----	-----	M	Wa-Nur
					70	-	-	-	-	-	-	-----	-----	--	Miss
6635-35					*69	VL	-	-	-	-	-	-----	-----	M	Wa-Nur
					70	-	-	-	-	-	-	-----	Replant July	M	Hold
6636-05	A-R	62002	51114	1/2 UT-WA, 1/8	*69	E	-	-	-	-	-	-----	F-type	M	Wa-Nur
		18 ♂	8-2BR, 1/16		70	M	M	-	-	-	-	-----	Short SA	P	Hold
		50 ♀	GCL, 1/16 SEM, 1/32 F, 5/32 X 1/16 LAN												

6636-06	A-R	62002	51114	1/2 UT-WA, 1/8	*69	L	-	-	-	-	-	-----	G. lup	M	Wa-Nur
			18 α	8-2 BR, 1/16	70	L	M	-	-	-	-	-----	Short SA, Hal-type	P	Hold
			50 β	LAN, 1/16 GCL, 1/16 SEM, 1/32 F, 5/32 X											
6642-07	A-R	19124	OP	5/16 F, 1/8 SERB, 9/16 X	*69	E	-	-	-	-	-	-----	F-type	M	Wa-Nur
					70	L	M	P	-	-	-	-----	Short SA	P	Hold
6650-13	M-R	19200	54066	1/8 URB, 1/16	*69	M	-	-	-	-	-	Downy mildew	G. cone	M	Wa-Nur
		46 α	42 α	LC, 1/16 F, 1/16											
		35 β	31 β	RV, 11/16 X	70	-	-	-	-	-	-	-----	Replant June, died July	--	Miss
6659-03	α	63020	63025	5/8 BG, 3/16	*69	L	G	G	M	9.7	5.8	Downy mildew	Top-set	G	Wa-Nur
		53 α	47 α	F, 1/16 EKG,											
		23 β	30 β	1/16 BAV, 1/16 X	70	-	-	-	-	-	-	Lf curl, mosaic	Replant July (Acc. No. 21005)	VP	Dis
6669-10	α	66030	OP	1/2 BUL, 1/2 X	*69	E	G	-	-	-	-	-----	G. lup	M	Wa-Nur
		50 α			70	L	M	-	-	-	-	-----	-----	M	Hold
		21 β													
6669-12					*69	L	-	-	-	-	-	-----	G. lup	M	Wa-Nur
					70	L	M	-	-	-	-	Yellow fleck, mosaic	Replant June	P	Dis
6669-28					*69	ML	-	-	-	-	-	-----	Two different vines	M	Wa-Nur
					70	M	M	-	-	-	-	Lf curl, crinkle	------	VP	Dis

6502-01	Sel-LxL	19209	19172	19/32 F, 1/4	*69	ME	G	-	M	-	-	-----	-----	M	Hold
		38 ♂	32 ♂	CAT, 5/32 X	70	M	M	G	-	-	-	-----	G. cl, F-type	P	Hold
		22 ♀	27 ♀												
6503-06	Sel-LxH	19209	19173	1/2 F, 1/4	69	M	M	-	G	-	-	-----	-----	M	Hold
		38 ♂	24 ♂	STRIES, 1/8	70	M	M	P	-	-	-	-----	Svr mites, P. cl		
		22 ♀	46 ♀	LC, 1/8 X									& SA	P	Dis
6503-27					69	M	G	-	M	-	-	-----	-----	M	Hold
					70	L	G	-	-	-	-	-----	G. cl.	M	Hold
6512-03	♂	64100	19060	1/2 BUL, 1/4	69	VL	M	-	M	-	-	-----	G. lup	M	Hold
		48 ♂	33 ♂	EKG, 1/8 BAV,	70	VL	G	-	G	-	-	-----	Bul-leaf, lge		
		23 ♀	45 ♀	1/8 X									burr, BG cone	M	Hold
6512-13					69	VL	M	-	M	-	-	-----	-----	M	Hold
					70	L	M	P	-	-	-	-----	-----	P	Hold
6512-27					69	L	-	M	-	-	-	-----	G. lup	M-P	Hold
					70	L	MG	-	G	7.0	4.7	-----	Bul-leaf, svr mites,		
													G. lup	P	Hold
6517-46	Ha-BC	56001	5937-00	3/4 HA, 3/16	*69	M	M	P	G	6.1	4.7	-----	P. cl.	M-P	Wa-Nur
		41 ♂		F, 1/16 X	70	-	-	-	-	-	-	-----	-----	--	Miss
		32 ♀													
6517-47					69	ME	M	-	P	6.0	5.1	-----	Var. cone, G. cl	M-G	Hold
					70	L	G	M-P	-	-	-	Lf necrosis	P. cl, var.		
													bloom	M-P	Hold
6517-50					69	ME	M	-	M	-	-	-----	-----	M	Hold
					70	E	M	P	M	-	-	-----	Red spider, low		
													lup, Hal-like	M-P	Hold

6527-01	Sel-HxH	60007	19137	1/4 STSP, 1/8 SU, 1/8 EG, 1/8 LC, 3/8 X	69	L	M	-	G	3.9	4.3	-----	Low lup, compact cone	M	Hold
					70	VE	M	M-P	G	-	-	Terminal cone, rust mottle	G. lup, 7-8b/Ac, lf drop, red spider, har 8/10	P	Dis
6527-06					69	M	G	-	G	3.7	3.5	-----	Low lup, dense cone	M	Hold
					70	M	M	P	G	3.5	3.7	Lf yellow	Short internodes, 7b/Ac, P. cl, dense cone, har 9/7	P	Dis
6527-16					69	L	G	G	M	3.1	1.4	-----	Low lup	M	Hold
					70	L	G	P	-	-	-	-----	Brushy, red spider, 6b/Ac, har 9/1	P	Dis
6527-17					*69	M	M	G	G	5.5	4.9	Rusty mottle	Dense cone	M	Wa-Nur
					70	M	M	P	G	-	-	Rusty mottle	P. cl, red spider, dense cone	M	Hold
6530-12	♂	63003	OP	1/4 BG, 1/4 UT-WA, 1/2 X	69	E	M	G	M	4.3	4.3	-----	-----	M	Hold
					70	ML	G	M	-	9.7	5.8	-----	G. cl, red spider	M	Hold
6532-06	OP	63018	OP	3/8 BG, 1/16 EKG, 1/32 BAV, 17/32 X	69	ME	M	G	M	6.9	4.0	-----	Cone shatter	M	Hold
		35 ♂			70	M	G	M	G	7.1	5.4	Top vein clearing	Brushy, G. lup, P. cl.	M	Hold
		30 ♀													
6532-15					69	VL	M	M-P	M	-	-	-----	-----	M	Hold
					70	M	M	M-P	-	7.4	7.0	Yellow fleck	P. SA, intersex, P. cl.	M-P	Hold
6535-08	♂	63021	OP	1/4 BG, 3/16 FU, 9/16 X	69	VL	G	-	G	-	-	-----	-----	M	Hold
		37 ♂			70	L	G	G	-	-	-	PNRSV, necrosis	G. cl, many cones /hill, var. cones	P	Dis
		40 ♀													

6536-06	∝	63008	OP	1/4 BG, 3/16	69 L	P	M	P	-	-	-----	G. cl.	M	Hold
		39 ∝		FU, 9/16 X	70 VL	G	G	M	-	-	Blighted	G. cl, var. cone	M	Adv.
		33 β									bloom			
6538-26	Ha-BC	56001	6210-00	3/4 HA, 1/8	69 L	M	-	M	-	-	-----	G. lup	M	Hold
		41 ∝		BUL, 3/32 BEL,	70 L	G	P	P	-	-	White	Genetic to AH,		
		32 β									varig. lf	varig. disappears,		
												var. matr.	P	Dis
6538-32					69 L	M	-	M	-	-	-----	G lup	M	Hold
					70 ML	G	M	M	5.1	2.9	-----	7b/Ac, Hal-type,		
												G. SA, brushy,		
												P. cl, har 8/31	G	Adv

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* The years data obtained from when the genotype was grown seedless in Oregon

1/ The 1969 alpha and beta percentages for the 6801, 6802, 6803 and 6806 represent the lupulin analysis. Likewise the alpha and beta of the female and male used in crossing represents lupulin analysis.

** Alpha and beta obtained from a loose sample of five (5) dried cones, extracted with toluene and calculated on as-is basis.

EXPLANATION OF PEDIGREE ABBREVIATIONS

ARIZ-WA	Wild American hop from Kaibab National Forest, Arizona, 1959
BAC	Baca grown in Oregon, 1956
BAV	Bavarian hop in Oregon, 1931
BEL	Belgian from Simeons, Belgium, 1936
BG	Brewers Gold from Salmon, Wye College, England, 1936
BUL	Bullion from Salmon, Wye College, England, 1939
CAT	Cat Tailfrom Salmon, Wye College, England
COLO-WA	Wild American hop from 35 miles south of Denver, Colorado, 1959
ECL	Early Cluster grown in Oregon, 1932
EG	Early Green from Blattny, Czech., 1933
EKG	East Kent Golding from Salmon, Wye College, England, 1932
F	Fuggle grown in Oregon, 1932
GCL	Golden Cluster from New Zealand, 1933
HA	Hallertau grown in Oregon, 1956
LAN	Land hopfen from Dir. Urb. Sta. France, 1933
LCL	Late Cluster grown in Oregon, 1932
LG	Late Grape from New Zealand, 1933
RV	Red Vine grown in Oregon, 1932
SEM	Semsch from Hampp, Bavaria, Germany, 1932
SERB	Serebrianka from Kovalevich, Zhitomir, USSR, 1936
STSP	Striesselspalt from Belgium, 1936
SU	Sunshine from England
URB	Seedling from Dir. Urbann Sta. France
UT-WA	Wild American hop from Logan Canyon, Utah, 1957
X	Parentage unknown because of open-pollination or imcomplete records

* The years data obtained from when the genotype was grown seedless in Oregon

1/ The 1969 alpha and beta percentages for the 6801, 6802, 6803, and 6806 represent the lupulin analysis. Likewise the alpha and beta of the female and male used in crossing represents lupulin analysis.

** Alpha and beta obtained from a loose sample of five (5) dried cones, extracted with toluene and calculated on as-is basis.

Other selections listed in the tables were planted during March 1970 from the following progenies obtained from Corvallis, Oregon:

1) Dr. A. Haunold's triploids, 25 selections
2) Genetic Study, 1968 progeny with $\alpha/\beta > 1.5$, 74 selections
3) Single-hill nursery, 1967 progeny, 85 selections
4) Mr. Liken's Trial Crosses for High Analysis study, 1966 progeny, 19 selections
5) Single-hill nursery, 1966 progeny, 29 selections

Many of the selections from the 1967 progeny did not survive due to the lack of irrigation water and poor planting stock. Missing selections were re-evaluated with Dr. Haunold in 1970 from his planting in Oregon and new plantings will be established in Washington during 1971. Progeny 6710, resulting from both parents having a high alpha content, appeared to have abundant cone lupulin and high alpha.

The twenty-nine selections from the 1966 nursery progeny displayed poor varietal potential grown under Washington conditions. Dr. Haunold made the same observation in Oregon with the 1966 nursery and in turn discarded all genotypes. Dr. Brooks made crosses 6621, -22, -23, -25, -28, -36, -42, and -50 in an attempt to study the inheritance of aphid and/or mite resistance on hops. Male and female parents were not selected for their heritability of yield or α-acid. Therefore, one can expect little "fall-out" or varietal potential from progeny which result from parents not selected for their productive potential. In contrast the 1966 progeny from the Trial Crosses for High Analysis study has several lines with commercial potential. Mr. Likens initiated this study to evaluate the heritability of parents selected with productive potential. The results of this study are published in previous Annual Reports of the Hop and Mint Investigations at Corvallis. The 19 selections planted in Washington performed similarily to what they did in Oregon during previous seasons. Their commercial potential is limited only by late maturity, which is a common shortcoming of most productive experimental hop lines.

The genetic study initiated in Corvallis by Dr. Haunold included reciprocal crosses, with parents of low and high alpha content lupulin, to study the inheritance of α-acid. The 1968 progeny established at Prosser in 1970 were selected from this study on the basis of floral clustering and a high α/β ratio of lupulin. The analyses of lupulin in 1969 and cones in 1970 were conducted in Mr. Liken's laboratory by Miss G. B. Nickerson. As reported by Mr. Likens in the 1969 Annual Report of Hop and Mint Investigations, crossing parents with high α/β ratios resulted in progeny with high ratios. Likewise, selections with high ratios in lupulin can also express this in the cone as indicated by the following data:

Selection	α/β Ratio 1969 Lupulin	1970 Cone
6801-30	2.3	2.4
6802-83	1.3	1.7
-89	2.6	3.3
-97	2.3	2.4
6806-01	2.6	3.0
-08	2.5	2.6
-22	2.3	3.2
-40	3.0	3.1
-52	4.0	3.7
-73	2.2	2.7
-81	2.1	3.1
-86	2.2	2.8
-94	2.5	2.5
-99	2.9	3.6

In most cases the ratios were greater from complete cone extraction than from lupulin. This difference may reflect differences in a) alpha content of lupulin located on bracteoles, or b) alpha content of lupulin on perianths. The 1969 lupulin analyses were obtained from hops grown under seeded conditions whereas the 1970 data were obtained from Washington grown seedless hops.

The following comments can be made regarding the 6801, 6802, 6803, and 6806 progeny:

1) Both male and female parents play an important role in determining chemical composition of progeny.

2) Analysis of lupulin is indicative of the chemical content of cones.

3) Late maturity and wild American cone morphology of the 63005 female parent was evident in 6801 and 6802 progeny.

4) Parents, 62013, and/or 6616-35M carry genes for earliness.

5) Female parent 19105 has outstanding genetic potential for transmitting clustering and cone number to progeny.

Fuggle triploid selections selected in Oregon performed poorly in Washington. Selections 6761-61 and 6761-117 merit consideration for advancement at this time. In general, the selections had an open undesirable seeded Fuggle-like cone, produced most of the cones on the upper portion of the vine, too late maturing, and displayed poor clustering on short floral laterals.

The following selections were discarded from the single-hill nursery after the 1970 growing season.

6801-25	6806-39	6705-07	6618-10
-42	-50	-12	6619-12
-46	-75	-15	6620-11
-57	-88	6710-21	-13
6802-75	-112	6712-01	6622-11
-86	6701-01	6717-18	-27
-100	-14	6733-05	6659-03
-119	-44	6759-03	6669-12
-148	6703-02	6761-35	-28
-151	6704-38	6618-02	6527-17
6806-15	-164	-03	

The following selections will be advanced to propagation and observation plots.

6801-60, 6803-01, 6806-22, 6710-49, 6761-61 and 6761-117.

Selections 6620-04, -10, -11, -12, -13, and -17 displayed excellent vigor and cone set (10,000 or more inflorescences per plant), but are late maturing. The male parent, 60013, used in this cross was a wild American selection and undoubtedly transmitted the tremendous number of floral initials and the lateness. Selection 6620-10 will be transferred to the germplasm block for future genetic studies.

The results from the single-hill nursery, based on observations in Oregon and one growing season in Washington are as follows:

1. Cross 6527 (60007 x 19173M) resulted in progeny with low α-acid and severe virus symptoms.

2. High analysis crosses (6616, 6618, 6620) using high analysis males resulted in high analysis progeny.

3. A relationship exists between virus symptoms in progeny and the male parent.

Cross	♂ Parent	Brewers Gold Progeny Virus Symptoms
6616	6639-09M	Late, yellow fleck, ringspot unlike Prunus or bacterial
6618	63023M	Late, PNRSV, severe necrosis
6620	60013M	Very late, rusty chlorosis

The female parent Brewers Gold displayed a yellow fleck symptom and is a known carrier of PNRSV.

4. Cross 6710 (Late Cluster x 63015M) resulted in progeny with good yield and high alpha, indicative of a high alpha male parent.

5. Fuggle triploids, 6759-03 and 6761-35 displayed severe split leaf virus symptoms with net necrosis and were discarded. During 1969 in Oregon many of the Fuggle triploids displayed split-leaf symptoms. Selection 6761-61 will be advanced because of its good storage property and 6761-117 warrants advancement to exploit its early maturity.

6. Progeny from crosses 6801 and 6802 displayed virus symptoms similar to their female parent, 63006.

7. Progeny from cross 6803 (19105 x 63013M) was the only population which did not display any virus symptom. All clones from 6803 were very vigorous and had excellent floral branching patterns indicative of the female parent.

8. Cross 6806 (62013 x 6616-35M) gave progeny with early maturity and a high α/β ratio. According to Dr. Skotland and Melouk's preliminary screen, female parent 62013 does not carry PNRSV, but 62013 progeny displayed various virus symptoms including PNRSV, rusty chlorosis, leaf curl and a leaf spot which Dr. Skotland indicated is not Prunus. In this case it would indicate that the male parent was transmitting the virus.

9. Majority of the selections discarded displayed moderate to severe virus symptoms.

Plans for the single-hill nursery next year include the replanting of 1967 progeny from Dr. Haunold and establishing the 55 selections (6901 and 6917) obtained from the seedling nursery in Washington.

Observation Plots

The observation block at Prosser consists of 5-hill plots of selections advanced from the single-hill nursery or from selections made at Corvallis.

Thirty-seven selections were evaluated in the observation block during 1970 of which 23 lines were planted in the spring. The fourteen two-year old plantings consisted of the following selections:

6308-25	62013
*6314-22	63006
6344-30	*63019
*6401-17	63020
6402-39	*63021
*6428-07	65011
6443-14	21001

* Lines were discarded after the 1970 season due to poor vigor and virus symptoms.

Selections 6616-19, 6619-15, 6659-11 were also discarded as "baby" plantings, after the 1970 season, due to severe mosaic, PNRSV, cirnkle-leaf, and other ringspot virus symptoms.

The following tables summarize the data obtained from the observation plots in 1970.

EVALUATION OF FIVE HILL OBSERVATION BLOCK AT PROSSER, 1970

Identification					Agronomic					Chemical 1/				
Acc/Sel	Cross	♀	♂	Pedigree	Yr	Mat	Vig	Yld	Cone	%α	%β	Disease	Comments	Eval	Dispos
6616-19	BG-BC	19001 48α 22β	6339-09	1/2 BG, 1/4 F, 1/4 COL-WA	*69	L	G	G	G	10.4	7.6	Bacterial ring-spot, hops downy mildew	Intersex, white	G	Wn-OB
					70	L	P	P	-	-	-	Bacterial RS, terminal cone, PNRSV, lf curl	Intersex	VP	Dis
6616-23					*69	L	G	G	G	10.4	6.0	Bacterial ring-spot, yellow fleck	White hops	G	Wn-OB
					70	VL	VG	G	VG	10.7	5.3	Fusarium	Dense cone, har 9/14, G. cl, best of 107	G	Hold
6619-01	BG-BC	19001 48α 22β	63025 47α 30β	3/4 BG, 3/16 F, 1/16 X	*69	L	G	G	G	11.7	4.5	lt chlor-osis	Intersex (Acc# 21004)	G	Wn-OB
					70	L	G	-	M	5.1	3.8	-----	Dense cone, P. cl, har 9/7, lup exudate	M-P	Hold
6619-05					*69	L	G	G	G	11.8	5.3	-----	13b/Ac	G	Wn-OB
					70	L	M	G	M	11.5	4.5	Terminal cone	♂ flwrs, var. cone, lge bracts, G. SA, har 9/7	M-G	Hold
6619-13					*69	M	G	G	G	11.4	6.2	-----	-----	G	Wn-OB
					70	M	M	M	M	7.4	5.1	Lf curl & necrosis, terminal cone	Top-set, ♂ flwrs, har 9/11, cock hops, P. cl.	P	Hold

6619-15	BG-BC	19001 48 α 22 β	63025 47 α 30 β	3/4 BG, 3/16 F, 1/16 X	*69 L 70 ML	G M	G P	G G	11.6 10.9	4.4 4.6	----- Crinkle-lf, vein clear., terminal cone, mosaic	Intersex H-1 miss, top-set, har 9/11, intersex, lf drop, P. cl.	G VP	Wn-OB Dis
6620-06	α	19001 48 α 22 β	60013 46 α 32 β	1/2 BG, 1/2 ARIZ-WA	*69 VL 70 VL	G G	G M	G P	9.0 -	5.8 -	----- (Necrosis in Ore), lf yellow	10,000 cone/H Talisman mat, many cones, fluffy cone, brushy	G M	Wn-OB Hold
6659-11	α	63020 53 α 23 β	63025 47 α 30 β	5/8 BG, 3/16 F, 1/16 EKG	*69 M 70 M	G VP	G P	G M	13.4 -	4.4 -	Yellow mottle Crinkle, lf curl, terminal cone, mosaic, yellow fleck	14 b/AC Svr virus	G VP	Wn-OB Dis
6659-12					*69 VL 70 VL	G M	G M	G -	6.1 -	8 3 -	----- -----	α/β < 1, cont-type Top-set	G M	Wn-OB Hold
6502-06	Sel-LxL	19209 38 α 22 β	19172 32 α 27 β	19/32 F, 1/4 CAT, 5/32 X	69 ML 70 L	G M	- MP	- -	- -	- -	----- -----	----- Weak SA, H3 weak, top-set, P. cl.	M MP	Wn-OB Hold
6503-25	Sel-LxH	19209 38 α 22 β	19173 24 α 46 β	1/2 F, 1/4 STR, 1/8 LC, 1/8 X	69 L 70 L	G G	G -	- G	7.4 -	3.2 -	----- Yellow fleck, terminal cone,	----- P. cl, red spider	G M	Wn-OB Hold
6512-11	α	64100 48 α 23 β	19060 33 α 45 β	1/2 BUL, 1/4 EKG, 1/8 BAV, 1/8 X	69 L 70 M	G M	M M	G G	8.2 7.2	3.1 2.6	----- Terminal cone, yellow fleck	P. cl, lge cone Red spider, lge var. cone, intersex, P. SA, har 9/11	M P	Wn-OB Hold

6517-24	Ha-BC	56001	5937-00	3/4 HA, 3/16	69	L	G	-	M	4.6	3.5	-----	Green var. cone	M	Wn-OB
		41 ∝		F, 1/16 X	70	L	G	M	P	4.4	4.0	Lf bronze & mottle	Sm. var. cone, lo lup, top-set, red spider	P	Hold
		32 β													
6532-03	OP	63018	OP	3/8 BG, 1/16	69	L	M	M	G	5.9	6.7	-----	G. lup, lge cone	M	Wn-OB
		35 ∝		EKG, 1/32 BAV,	70	L	M	M	M	6.1	7.5	-----	P. cl, red spider, G. lup, P. SA, top-set, open cone	M-P	Hold
		30 β													
6532-04					69	VL	M	-	M	7.7	4.8	-----	White hop, var. cone	M	Wn-OB
					70	VL	M	M	P	7.3	4.9	-----	Var. open cone, 10 nodes 1 1/2", top-set, red spider, har 9/7	P	Hold
6532-14					69	L	G	M	G	10.4	4.2	-----	G. cl & lup	M	Wn-OB
					70	ML	M	M	G	9.7	4.5	Lf drop & yellow fleck	H2 & 5 miss, sm. dense cone, top-set, G. lup, har 9/11	M	Hold
65002	∝-6401	19208	19058	1/2 LC, 1/4 EG,	*69	ML	G	G	M	8.0	6.8	Lf bronze	Cock hops (Ore data)	M	Wn-OB
		50 ∝	33 ∝	1/4 X											
		34 β	49 β		70	VL	M	M	-	-	-	Necrosis @ wire, lf bronze	Top-set, G. SA	M	Hold
65009	∝-6407	19001	19058	1/2 BG, 1/4	*69	M	M	M	G	13.1	9.3	Rusty mottle	White hops (Ore data)	G	Wn-OB
		48 ∝	33 ∝	EG, 1/4 X											
		22 β	49 β		70	VL	M	P	G	-	-	Yellow fleck, lf bronze	Dense cone, H3 virus disc, top-set, H5 miss, P. cl	P	Hold

65011	α-6407	19001	19058	1/2 BG, 1/4	*69	L	M	-	G	12.1	7.8	-----	G. cl, (Ore Qual. data)	M	Hold
		48 α	33 α	EG, 1/4 X											
		22 β	49 β		70	ML	VG	G	G	6.2	8.8	-----	Dense cone, hopped down, har 9/7	G	Adv
6401-17	α	19028	19058	1/2 LC, 1/4	69	VL	G	M	P	-	-	-----	VG lup	M	Wn-OB
		50 α	33 α	EG, 1/4 X	70	VL	G	-	-	-	-	Vein clearing, lf curl	Destroyed Aug (virus), very long SA	VP	Dis
		34 β	49 β												
6402-39	α	19028	19060	1/2 CL, 1/4	69	L	M	M	G	7.7	4.2	-----	G. cl, WA	M	Hold
		50 α	33 α	EKG, 1/8	70	L	G	G	G	-	-	-----	Var. cone, G. lup & cl.	G	Hold
		34 β	45 β	BAV, 1/8 X											
6428-07	α-DM-R	19151	19060	1/4 F, 1/4	69	M	M	M	M	5.3	3.4	-----	Lo lup, G. cl, open cone	--	-----
		18 α	33 α	EKG, 1/8 BAV,											
		42 β	45 β	1/8 RV, 1/4 X	70	L	G	G	M	-	-	Slip-down	Too brushy, cluster-type	MP	Dis
6443-14	OP	19208	OP	1/2 LC, 1/2	69	ML	G	G	G	5.2	4.1	-----	HA-type, BIS sample fair rating	MG	Hold
		50 α		X											
		34 β			70	ML	VG	VG	M	4.8	4.1	-----	P. climber, G.cl, 12 b/AC, BIS sample '70, har 8/27	G	Adv
64007	Sy-6321	19105	19058	1/4 EG, 3/16	*69	L	G	G	G	5.1	4.3	Lf bronze	BIS '69 good rating (Ore data)	G	Wn-OB
		6 α	33 α	F, 1/8 LG,											
		45 β	49 β	7/16 X	70	L	G	G	M	-	-	-----	G. cl, var. cone & bloom (BIS Ore)	G	Adv
64024	BC-6307	19001	5928-00	3/4 BG, 1/8	*69	M	G	G	G	7.7	3.6	Lf necrosis	Dense cone (Ore data)	M	Wn-OB
		48 α		EKG, 1/16											
		22 β		BAV, 1/16 X	70	L	M	-	G	-	-	Lf drop & necrosis	Dense cone, irreg. lf lobing	P	Hold

6308-25	BC	19001	19182	1/2 BG, 1/4 BUL,	69	L	G	M	M	7.9	5.3	-----	G. lup	M	Hold
		48 ♂		3/16 BEL, 1/16	70	ML	M	M	M	8.9	6.2	-----	G. cl, H4 weak,		
		22 ♀		X									open cone, HA-type,		
													♂ flwrs, G. lup	M	Hold
6314-22	BC	56002	19062	1/2 BAC, 1/4	69	L	M	M	M-P	4.6	4.7	-----	Var. cone	P-M	Hold
		37 ♂		EKG, 1/8 BAV,	70	L	M	M	M	5.1	5.0	Fusarium,	P. cl, red spider,		
		46 ♀		1/8 X								lf curl,	har 9/7, weak SA,		
												mosaic, lf	brushy, lf drop	P	Dis
												bronze			
6344-30	BC-6205	19001	58015	1/2 BG, 1/2	69	ML	G	G	G	6.4	4.0	-----	Lo lup, WA aroma	M	Hold
		48 ♂		UT-WA	70	L	VG	-	M	6.5	3.9	-----	Cl-type, brushy,		
		22 ♀											har 9/7, cock-hop,		
													G. cl, 13b/Ac	G	Adv
63006	BC-6205	19001	58015	1/2 BG, 1/2	69	L	M	G	P	9.2	5.1	-----	G. lup, WA, lge		
		48 ♂		UT-WA									cone	M	Hold
		22 ♀			70	L	VG	M	M	-	-	Fusarium,	Weak SA, red spider,		
												H3 yellow	25% ♂ flwrs, G.		
												fleck	lup	P	Germ
63019	BC-6206	19001	5928-00	3/4 BG, 1/8	69	L	G	-	M	4.2	3.4	Yellow	G. lup, var. cone	M	Hold
		48 ♂		EKG, 1/16 BAV,								fleck			
		22 ♀		1/16 X	70	VL	G	P	M	-	-	-----	P. cl, var. bloom	P	Dis
63020	BC-6206	19001	5928-00	3/4 BG, 1/8	69	L	M	M	M	-	-	Yellow	G. lup	M	Hold
		48 ♂		EKG, 1/16 BAV,								fleck			
		22 ♀		1/16 X	70	L	VG	G	G	6.8	3.6	Lf burn,	Har 9/11, brushy,		
												yellow	lf necrosis in		
												fleck	Aug.	M-G	Off-Sta

63021	BC-6204	19001 48 ∝ 22 β	19040 39 ∝ 30 β	1/2 BG, 3/8 F, 1/8 X	69 70	M VL	M G	- M	M M	- -	- -	----- -----	G. lup H3 red vine, too late, brushy, red spider	M P	Hold Dis
62013	WA-6185	19120 53 ∝ 18 β	58006	1/4 SU, 1/2 UT-WA, 1/4 X	69 70	ML L	G G	G G	G M	11.6 7.0	4.4 3.7	----- Fusarium	Eval by extractors (good) Lf cupping like Bul., har 9/11, (13% ∝ off-station)	G G	Adv Off-Sta
21001		F - Budsport			69 70	E VE	MP M	M M	M M	- 3.4	- 4.8	----- -----	Similar to Ore SL Late trained best, long cone, red spider, har 8/24	M G	Adv Off-Sta
NW 12-20		F - Budsport			*69 70	VE VE	M M	M M	G G	- -	- -	----- Lf bronze	Hal-type Top-set	M M	Wn-OB Hold
UI-40	Eur.	EC 48 ∝ 34 β	OP	1/2 EC, 1/2 X	*69 70	ML L	G G	G G	M M	6.5 5.7	5.3 5.5	----- Irreg. lf lobing, chlorosis	BIS'69 good rating (Ida data) Var. open cone, G. cl & lup	G G	Wn-OB Hold

Explanation of pedigree abbreviations on page 45.

* Data obtained when grown seedless in Oregon.

The virus symptoms listed under disease such as; leaf curl, leaf crinkle, vein-clearing, yellow mottle, yellow fleck, bronzing are self-explanatory. "Terminal cone" is used to describe a condition when the apex terminates as a cone in which the strig is elongated 18 to 24 inches.

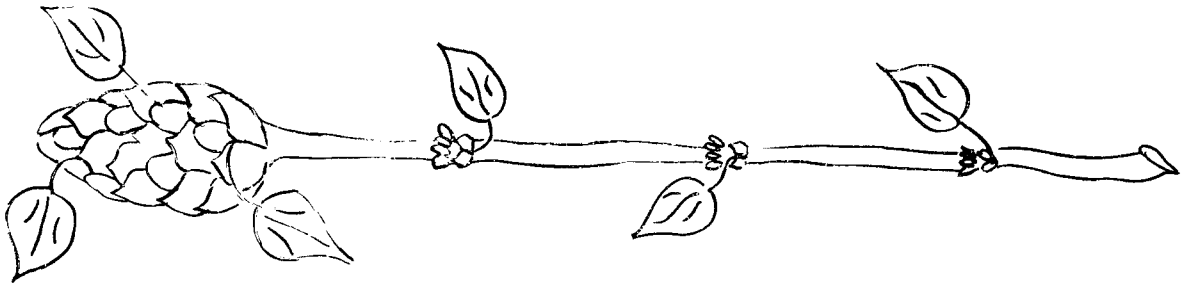


Illustration of "terminal cone" with the typical "cock-hop" apex. Internodes are 6 to 10 inches in length.

Vestigal bracts and bracteoles occur at each node and contain lupulin glands. The ordate leaf which originates from between the bracts is two inches wide and dwarfs the bracts and bracteoles.

This condition was described by Dr. Robourgh as existing in New Zealand. Dr. Horner and I observed this condition in 56008, which was planted off-station, and related it to the yellow-fleck virus expressed by this genotype.

General comments based on the 1970 data from the observation blocks are as follows:

1) Selections with virus expressions display poor vigor and quality. Hop virus is the most detremental disease in the Yakima Valley.

2) Some selections displayed a succeptability to Fusarium, as 62013. The infection occured at the base of the vine, above the soil-line, and was associated with damage from hand stripping or chemicals.

3) Selection 6619-01 analyzed 12% α in 1969 and 5% α in 1970 with a virus expression. Lupulin glands appeared to have extruded part of their contents. This condition was also noted in Oregon during past years with selection 58112.

4) Selection 65009 is a high alpha line, but one hill displayed severe virus symptoms. The hill was discarded though there is concern for the purity of the other hills and their future propagation.

5) Selection 6616-23 is the best line from the Liken's Trial Crosses for High Analysis. This selection is still late maturing like the other lines from this study.

6) Selection 21001 had a low α-acid of 3.4%. The brewery interested in this selection still regarded it as having potential for replacing their imported stock.

7) A severe wind storm on September 10 removed up to 100% of the cones from some plots. Selection 62013 was harvested after the storm and cones analyzed only 7% α-acid.

8) Selection 63006 was transfered to the germplasm block. This genotype has leaf glands which have been analyzed for α-acid during 1969 in Oregon and 1970 in Washington.

9) Selection 6443-14 is considered as a replacement for imported hops. A hand sample was evaluated by the USBA Hop Research Subcommittee in 1969 and 1970. Two large breweries using imported hops rated 6443-14 as having good potential.

10) The following selections have sufficient potential for advancement into the varietal development program:

6344-30	64007
6443-14	65011
62013	21001
63020	

Selections 21001, 64007, and 6443-14 are "back-up" lines for 56013 and the import-type hop. Selection 6344-30 has potential as a "Cluster" replacement if it has good storage properties. Off-station plantings of 62013 are supported by the high analysis lines 65011 and 63020.

In summary, it was a great disappointment to observe the collapse of selections from virus which in previous years produced 14 bale per acre at 13% α-acid (6659-11). The main concern in the future should be to screen selections for virus and to determine the cause for an increasing occurence of virus symptoms. There are indications that progeny from parents which carry a virus will also display the virus. Dr. Skotland believes that hop viruses may be seed borne. Evidence that pollen is not a vector is inconclusive.

Several lines from the single-hill nursery will be advanced to the observation block in 1971.

Propagation

A propagation program provides a source of planting stock from all selections advanced to the observation block. This planting material is destroyed following the discard of the selection. During the development of a selection planting stock provides material for:

a) Downy mildew test
b) Virus screen
c) Verticillium evaluation

d) Off-station observation plots
e) Yield trials
f) Off-station brewing trials
g) Nuclear stock to Experiment Station

The following material was planted for propagation during 1970:

6616-20	6618-19	65011	Brewers Gold (Or)
-03	6619-01	64007	Talisman (Or)
-04	-05	64024	E-2 (Or)
-05	-15*	64026	Pride of Ringwood (Or)
-11	6620-06	6314-22*	56013
-16	6659-11*	62013	66030*
-19*	-12	Fuggle (Or)	Bullion-3c
-20*	6503-25	Fuggle-N-10c	-6a
-23	6532-14	NW 12-20	-10a
6618-01	6517-47	UI-40	19110*
-10*	65002	21001	NZ 55-6-29*
			NZ 57-3-51*

* Selection was discarded from program following 1970 season.

Propagation techniques were similar to those developed in Oregon consisting of close-planted rhizomes and/or rooted softwoods and layering shoots during June.

Germplasm Block

This block consists of three hill plots of genotypes retained for their genetic potential or genetic evaluation. Hop lines grown in the germplasm block during 1970 were as follows:

Genotype	Genetic Potential	Comments
NZ 57-3-51	Foreign Introd.	Mod. PNRSV, V. Late
NZ 55-6-29	Foreign Introd.	Sv. PNRSV, V. Late
19110	Eur. Char. & Yield	Spl-leaf, V. Late
19137	Eur-WA heterosis	M. Late
19120	Eur-WA heterosis	M. Late
6619-04	Lupulin-α/gland	Sv. PNRSV, Late
6620-01	Storage-V. poor	V. Suscep. D. M.
66030	Bullion nucleus	Mod. PNRSV
Pride of Ringwood	Lupulin-cone #	V. Late
*Brewers Gold-4c	Virus-free	♂, Large cone
*Brewers Gold-9a	Virus-free	♂♀, Large cone
*Bullion-3c	Virus-free	-----
*Bullion-6a	Virus-free	Best line
*Bullion-10a	Virus-free	-----

* Virus-free clones of commercial varieties were obtained from Dr. C. B. Skotland by a heat-treatment technique.

The following clones of additional virus-free material were planted later during the 1970 season: Rivard Cluster-6b, -9c, -11c, -14c, -15b, -15c; Alliance-6c, -7c, -8b, -11b, -12c; and Northern Brewer-H4, -H6, and -H9.

Genotypes NZ 57-3-51, NZ 55-6-29, and 6619-04 were discarded from the germplasm block due to the severity of the PNRSV expression. During 1971, germplasm will be added which has gene potential for inflorescence number and any additional germplasm which Mr. Roberts, at Corvallis, wishes to maintain in Washington because of its susceptibility to downy mildew under Oregon conditions.

Commercial Variety Block

This block was established for a comparative evaluation of commercially grown hops in the Yakima Valley.

Variety	Maturity	Vigor	Comments
E-2-Or	E	G	Mod. PNRSV, g. SA's
L-1-Or	ML	G	Variable growth
56013	L	M	Mod-Sv. PNRSV
Brewers Gold-Or	VL	G	Mod. PNRSV
*Brewers Gold-Wn	--	-	Sv. PNRSV
Bullion-Or	L	G	Mod-Sv. PNRSV
*Bullion-Wn	--	-	Sv. PNRSV
Talisman-Or	VL	VG	No virus expression
Talisman-Wn	VL	G	Sv. PNRSV, Y. fleck
Fuggle-Or	VE	P	Mosaic, lf bronze, sv. mites
Fuggle-N-10c	VE	P	Lf. curl & bronze, term. cone, sv. mites
*Northern Brewer	--	-	Sv. PNRSV, line pattern
Pride of Ringwood	VL	G	VG clusters, no virus

* Plants were destroyed during July, 1970 due to concern for virus.

The following lines will be considered for additions to this block:

1) Virus-free Bullion-3c, -6a, and -10a
2) Experimental lines 21001 and 62013
3) Virus-free Cluster: L-8, L-16, and E-21

Commercial plantings of each variety listed above exists in the State of Washington.

Talisman hops developed glossy, variegated, leathery appearing leaves in addition to the typical PNRSV expression (Figure 1 and 2).

Figure 1. PNRSV symptoms on Talisman flowering branch. Photo by Dr. C. B. Skotland on 18 June 70.

Figure 2. PNRSV symptoms ten days later on same flowering branch as above. Photo by Dr. C. B. Skotland.

Off-Station Observation Plots

Small plots planted with experimental lines or varieties provide information concerning the adaption and commercial evaluation of hop lines prior to larger plantings for brewing trials.

Experimental lines 21001 and 62013 are scheduled for brewing trials beginning in 1971. It is advantageous to plant one of the observation plots at the grower scheduled for the pending brewing trial. This provides an opportunity to evaluate the grower's cultural practices first-hand. Because of the shortage of planting material it was only possible to establish one plot, one location each of 21001 and 62013.

a) Experimental line 62013

Twenty hills were planted at the Yakima Chief Ranch, located near Mabton, in March 1970. The small, single rhizome planting stock produced only 2 to 3 vines per hill. Seventeen hills were harvested by machine on 10 September and yielded an average of 7 pounds green hops per hill. Cones were harvested with considerable shatter associated with the 1-3 seed content of cones. Many harvested cones were picked with a portion of the peduncle still attached. This condition is characteristic with this genotype and is enhanced when grown under seeded conditions.

Fifteen two-pound bales were prepared and sent to Pfizer, Inc. at Brooklyn, New York for evaluation as an extract-type hop. Analysis was provided by Mr. S. T. Likens (Lab no. 148) as 13.2% α, 4.2% β-acid and 1.9 mls oil.

In 1971 a planting of 62013 will be established on the Yakima Chief Ranch and consist of approximately eight acres. Pfizer, Inc. will evaluate the hop as an extract through the brewing process. Their operation requires a minimum of 5,000 pounds of dried hops, but prefer 20,000 for an adequate test trial. An additional two-acre brew trial of 62013 is also scheduled in Washington for evaluation by other brewer interest.

The following information sheet was prepared for Washington cooperators scheduled to grow 62013 for brewing trials during 1971-73. Agronomic information was obtained from observations in Oregon under seedless growing conditions and in Washington during 1970. Chemical and disease data obtained from Mr. Likens and Dr. Horner at Corvallis.

INFORMATION SHEET FOR USDA
EXPERIMENTAL HOP VARIETY 62013

The hop was selected at Corvallis, Oregon in 1967 for its high analysis and high yield potential under seedless growing conditions. 62013 can produce 200 to 250 pounds of α-acid per acre. This fact should be given consideration when establishing a market for 62013.

PEDIGREE: 1/2 Utah Wild American, 1/4 Sunshine, 1/4 X (Sunshine is an English variety with yellow foilage)

MATURITY: Late, September 5 - 15.

YIELD: 10 - 12 pounds green hops per hill or 10 to 12 bales per acre.

GROWTH HABIT: Produces early shoots which are often too large for training. Later shoots are still large and require care in training. Shoot tips are easily broken if trained during cool weather. Trained shoots have a tendency to blow off the string due to rapid daily growth and/or poor initial training job.

Early spring growth has a characteristic yellowing of young leaves. Leaves gradually acquire a yellow-green color during the growing season. Sunlight speeds up the development of the green coloring.

62013 remains in the burr stage for an extended period of time prior to cone development. The vine tends to be "hopped down" but the majority of cones are produced on the upper 1/3 of the vine. Sidearms are long and become tangled in the upper portion of the vine producing a "head". Mature main vine leaves are cupped downward with prominent ridges between the veins.

Vine growth extends 4 to 8 feet beyond a 18 foot trellis. Vine growth which fails to grow over the cross wire will result in vine slip-down or broken strings.

PROPAGATION: Produces adequate cuttings of good quality. Sucker growth should not be removed after July 1. Avoid hand stripping near the soil line.

DISEASE REACTION: Downy mildew tolerance similar to Bullion, and better than Clusters. Has tolerance to strains of Verticillium wilt found in the Pacific

Northwest hop areas. No virus symptoms have been observed in 62013. Vines injured near the soil line may become infected with Fusarium.

PICKING: Picker adjustment should be similar to that used with Cluster or Bullion hops. Different adjustments may be necessary on re-cleaners and dribbles. Seeded cones will easily shatter and require additional adjustment in picking procedure.

DRYING - BALING: To minimize the loss of brewing value: a) Dry at 140°F or at as low a temperature as practical. b) Use maximum air flow to reduce time and moisture differential. c) Avoid over-drying, a bale moisture of 9 to 10% is recommended. d) Minimize breakage during kiln removal and later handling. e) Reduce baling pressure to obtain 190 pound bales. f) Place bale in freezer or cooler (35°F) within 24 hours.

CONE TYPE: Cones are large, 2" or more in length, loose and open at the tip. This condition often requires less air on the re-cleaners and an increased angle on dribbles to reduce cone loss. Cones have from 60 to 84 petals (bracts and bracteoles) on a core (strig) which averages 1 1/2 inches in length. Cones are easily picked, but a large percentage are picked with a short stem still attached. One or more seeds per cone greatly increases the petal size and results in excessive shatter. Cone color and shape are very similar to the Cluster-type hop. Large bracts are conspicuous and enclose most of the bracteole.

CONE ANALYSIS: Alpha-acid - 11 to 12%; Beta-acid - 4 to 5%; ml. oil per 100 grams - 1 - 2.5.

LUPULIN: Abundant, lemon-yellow color. Developed glands contain 50% alpha and 20% beta-acid.

AROMA: Characteristic Wild American or Cluster-type.

STORAGE STABILITY: Similar to that of Bullion. Should be refrigerated or frozen immediately as is practical after baling.

b) Experimental line 21001

Twenty hills were planted at the Eli Patnode Hop Ranch, located near Grandview, in March 1970. Dr. Skotland planted Bullion, Northern Brewer, and Fuggle adjacent to the 21001 plot. Moderate to severe virus symptoms were displayed by all varieties evaluated at this location, except 21001. Several hills were harvested by hand on 28 August and yielded 4-5 pounds of green hops per hill.

Dried cones were pale in color and did not have the characteristic aroma associated with European hops. Mr. Liken's analysis (Lab. no. 223) of a baled sample was 5.0%α, and 5.4%β-acid. Adolph Coors Company was sent a one-pound bale of 21001 grown off-station and a bale from 21001 grown on-station at Prosser. They reported that the off-station lacked aroma and preferred the on-station sample.

Adolph Coors Company will test brew bales produced from a two-acre planting of 21001 scheduled for the Scymanski Hop Ranch located near Whitstran in 1971.

The following information sheet was prepared for the scheduled off-station brew trial in Washington during 1971-73.

INFORMATION OUTLINE FOR USDA EXPERIMENTAL HOP VARIETY

21001

The hop was selected in 1961 from a commercial Fuggle yard in Oregon. Basis for the selection was a characteristic continental aroma, desirable cone type, earliness, and a yielding potential greater than Hallertau or Fuggle.

PEDIGREE:	Unknown, has Continental-type characteristics.
MATURITY:	Early, August 10 - 20.
YIELD:	6 to 7 pounds of green hops per hill or 6 to 7 bale per acre.
GROWTH HABIT:	Produces an abundant number of shoots for training. Shoots are easily trained onto coir or paper string. Vigorous sucker growth during mid-season results in numerous rhizome cuttings the following year. Requires close hoeing in spring. Small vines favor training three vines per string or six per hill. Moderate vine growth produces normal crop on less than 18-foot trellis. Vines are "hopped down" to the arch. Cones are evenly distributed the length of the vine. Sidearms are longer than Fuggle, averaging 24 to 30 inches in length. 21001 reaches a full burr stage during late June. Developing cones are visible two weeks later. Vines may "hang" for two to three weeks in a full cone stage before the development of a desirable

continental-type aroma.

PROPAGATION: Produces an over-abundance of good quality cuttings. Suckering until July 1 is beneficial in reducing the production of cuttings. Later suckering should be avoided to permit regrowth prior to the early harvest date.

DISEASE REACTION: Downy mildew tolerance similar to Bullion, and better than Clusters. Has tolerance to strains of Verticillium wilt found in the Pacific Northwest hop-producing areas, but should not be planted on land known to be heavily infested with Verticillium wilt. No virus symptoms have been observed in 21001.

PICKING: Cones pick easily, (less than 3/4 pound-force) resulting in very little shatter. Sidearms are picked clean and remain attached to the vine.

DRYING - BALING: Dries easily; care shoud be taken not to overdry. Recommend a baling moisture of 9 to 10%.

CONE TYPE: Variable size, ranging between 1/2 to 1 1/4 inches in length, medium density and open at the tip. Cone have from 42 to 72 small petals (bracts and bracteoles) on a medium size core (strig). Average cones have shape and color similar to Halleratuer. Developed cones "hang well" and become yellow-green when mature.

CONE ANALYSIS: Alpha-acid - 5 to 6%; Beta-acid - 4 to 5%; ml oil per 100 grams - 0.5 to 1.0.

LUPULIN: Small amount, lemon-yellow color. Developed glands contain - % alpha and - % beta-acid.

AROMA: Continental, Hallertauer-type. Harvest date determined by aroma intensity.

STORAGE STABILITY: Good, similar to Talisman.

Off-Station Brew Trials

These trials are conducted for 2 to 3 years in one or more locations within a hop growing area to provide yield data and bale lots for full scale test brews. Since the trials are established within a commercial yard, the minimum size of two acres is sufficient to be harvested, dried, baled separately. Following two successful test brews, with favorable agronomic data, an experimental hop line is eligible for release as a commercial variety.

In 1970, two off-station brew trials were established in Washington with experimental hop 56013 as follows:

a) Wayne Hogue Hop Ranch

Location: near Prosser
size: 0.6 acre (spaced 7' x 7')
harvest: 9 September
yield: 8 bale per acre
analysis: 7.0% α, 6.5% β, 0% leaf-stem, 0% seed
Test brew: Extracted by Hop Extract Corp. in Yakima, brewed by Jos. Schlitz Brewing Co. at Milwaukee, Wis; Miami, Fla; and Los Angeles, Calif.

b) John Segal Hop Ranch

location: near Grandview
size: 0 9 acre (spaced 7' x 7')
harvest: 15 September
yield: 6 bale per acre
analysis: 6.2% α, 6.4% β, 0% seed, 1.0% leaf-stem
Test brew: Extracted by Hop Extract Corp. of America in Yakima, brewed by Jos. Schlitz Brewing Co. at Milwaukee, Wis; Miami, Fla; Los Angeles, Calif.

Both trials were planted in early March 1970 with small rhizomes which are undesirable for planting under the dry spring conditions in Washington. Despite the cuttings, a 99% stand was obtained at both locations and missing hills were replaced during June. The ringspot symptoms associated with PNRSV appeared during May and June on approximately 25% of the hop hills, but less than 1% of the early symptoms became necrotic.

Figure 1 and 2 display the early virus symptom followed by the near absence of expression ten days later As is evident in Figure 1 the symptoms were limited to the rapid growing meristematic areas of the vine

The hot-cool-hot temperature cycle during June was favorable for virus expression and probably altered the physiology of the plant. Experimental line 56013 has a genetic make-up which produces sterile male inflorescences under certain temperature regimes. Following the temperature changes during June the apical growth of 56013, at both trials, terminated into an elongated cone 12 to 24 inches in length. As discussed under the section Observation Plots, this growth habit may be associated with a virus. In early June, the rapid growth of 56013 indicated that the vine growth would cross the wire at 18 feet within two weeks, but the virus expression terminated growth below the wire.

Figure 1: PNRSV symptoms on 56013 vine leaves. Photo taken by C. B. Skotland on 18 June 70.

Figure 2: PNRSV symptoms on the same 56013 leaves as shown in Figure 1, photo taken 10 days later by C. B. Skotland.

Figure 3 shows the ringspot symptoms in comparison with normal hop leaves from 56013.

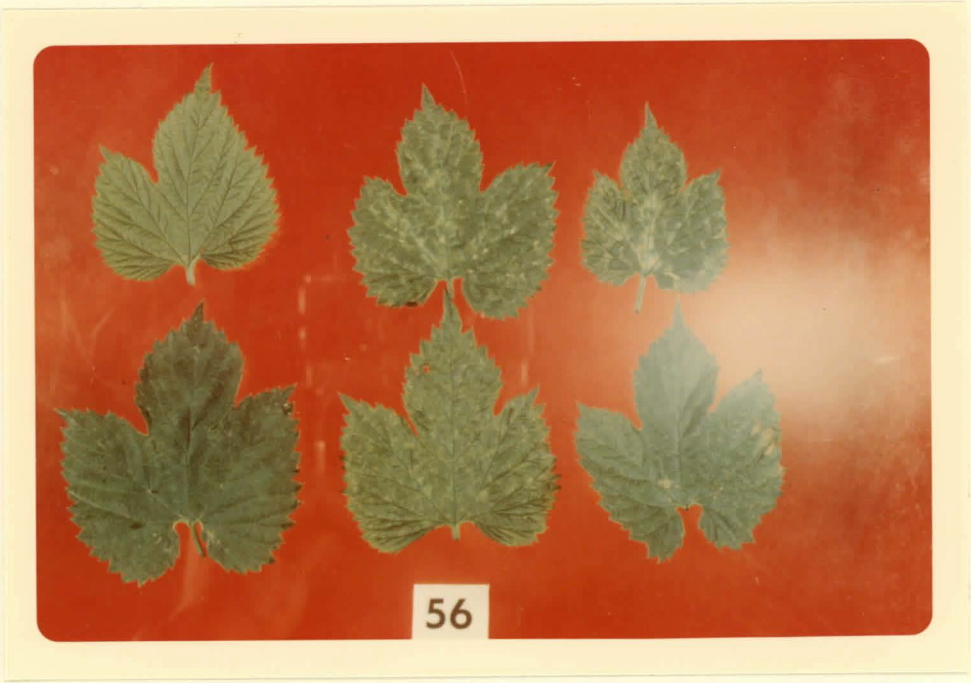


Figure 3. PNRSV symptoms on 56013 leaves displayed 5 days after day temperatures were reduced 20 degrees. Normal leaves on left. Photo by C. B. Skotland, 17 June 70.

Nearly all of the 56013 plants at the Segal trial produced varying amounts of male inflorescences in early July. Some hills had entire floral branches bearing male flower clusters resembling mistletoe. Yields were reduced at least 50% on hills which displayed male flowering laterals and 5 to 10% on hills which had male floral clusters interspersed with female flowers.

Both off-station cooperators were enthusiastic over the picking and yield of 56013 though there was concern over the occasional male flowers attached to the peduncle of the dried cone.

In November 1970, the 0.6 acre planting at the Hogue Ranch was increased to 4.5 acres on adjacent new land. The Segal trial was removed in November for expansion onto new land in the spring of 1971.

Plans in 1971 are to have approximately 15 acres of 56013 in commercial production at the two locations with an estimated production of 75 bale for brewing test by Adolph Coors Company. New off-station plantings are scheduled in 1971 to include experimental line 62013 and 21001.

The following information sheet was prepared for the two off-station cooperators growing 56013 for brewing tests during 1970-71.

INFORMATION SHEET FOR USDA
EXPERIMENTAL HOP VARIETY 56013

The hop was selected at Corvallis, Oregon in 1956 for its tolerance to downy mildew and yield potential. Its continental quality was later recognized by U.S. brewers using imported Hallertauer hops.

PEDIGREE: 5/16 Fuggle; 1/8 Serebrianka; 9/16 unknown. (Serebrianka is a Russian variety)

MATURITY: Late, September 1 - 10.

YIELD: 10 - 12 pounds green hops per hill or 10 to 12 bales per acre.

GROWTH HABIT: Produces abundant, erect, slender, easily trained shoots. The vines twine closely to the string and do not tend to slip down or fall away. 56013 forms an even growth up and over the wire without a dense "head". Hops are well-distributed up and down the vine ("hopped down") in definite "clusters".

The cones "hang well", that is they hold quality and color for 10 to 20 days after reaching adequate maturity for harvest. 56013 withstands adverse weather conditions without discoloration better than other varieties. Sterile male flowers may develop within "clusters" following unusual temperature changes in spring.

PROPAGATION: Produces rhizome cuttings abundantly when properly managed. Care must be taken to adequately prune the hill because it tends to spread out unless cut back closely. Sucker growth should not be removed after July 15.

DISEASE REACTION: Has resistance to downy mildew better than Bullion but not as good as Fuggle. Has tolerance to strains of Verticillium wilt found in Pacific Northwest hop-producing areas, but should not be planted on land known to be heavily infested with Verticillium wilt. Apparently carries prunus necrotic ringspot virus. Develops grown gall occasionally.

PICKING: Compact cones pick easily, (less than 3/4 pound-force) resulting in very little shatter. Basal bracts (petals) usually remain attached to the stem after the cone is picked.

DRYING - BALING: Dries easily; care should be taken not to over-dry. When dried to 8 to 9% moisture, it

bales well and produces a very attractive inspection sample. Excessive shattered or broken cones would indicate over-drying and/or poor handling.

CONE TYPE: Dense medium size averaging 1 1/2 inches in length. Cones have from 60 to 84 petals (bracts and bracteoles) on a core (strig) which averages one inch in length. Overlaping petals produces a four sided pointed cone. The terminal cones often display one or more leaves in the cone, "cock-hops". These cones are usually larger than normal. 56013 cones are darker green than present commercial varieties. This is often mistaken for immaturity but is a variety characteristic.

CONE ANALYSIS: Alpha-acid - 6 to 8%; Beta-acid - 5 to 7%; ml oil per 100 grams - 1 - 2; Cohumulone content of α-acid - 15 to 25%; Oil composition - similar to Fuggle, Styrian, Spalt, or Tettnang in farnesene content, no unusual features.

LUPULIN: Plentiful, of yellow to orange color. The deeper yellow-orange color of the lupulin is natural and should not be attributed to over-drying. Lupulin averages 40% α-acid and 30% β-acid

AROMA: Characteristic.

STORAGE STABILITY: Similar to that of Bullion. Should be refrigerated within a week after harvest. 26^{0} C appears to be adequate for practical storage.

This information supplements item 3 on the production practices form completed by the off-station grower. This form is a modification of the one developed by Dr. Brooks in 1967.

ADVANCED HOP YIELD TRIAL PRODUCTION PRACTICES EXPERIMENTAL HOP TRIAL

1. Name, address, telephone number

2. Selection _____
   No. hills _____
   Crop year _____
   Planting date _____
   Roots/hill _____

3. Information from previous years: _____

4. Soil analyses:

   Soil type _____ OM (%) _____
   P (ppm) _____ Salts (Mmhos/cm) _____
   K (ppm) _____ B (ppm) _____
   pH _____ Zn (ppm) _____
   Comments and recommendations: _____

5. Fertilizer program:

Material	Rate/A	Date
Manure		
Gypsum		
NH_3		
N		
P		
K		
Other (specify)		

6. Date plowed _____
   Date hoed _____
   Dates trained _____
   Were vines returned _____
   Kind cover crop _____
   Trellis height _____
   Spacing _____

   Irrigation program

Dates	Duration

   Comments and recommendations on growth habit: _____

7. Disease and insect control program: (include zinc sprays)

Material	Rate/A	Date

8. Comments on disease and insects:

9. Date spring growth evident _____ Comments:
Date vines reached wire _____
Date of flowering, initial _____
full _____

10. Harvest date _____
Comments on picking and shattering: _____

11. Drying conditions:

Sulphur _____ Air Velocity _____
Temperature _____ Other comments _____
Depth of bed _____
Time required _____

12. Production data:

Total pounds produced _____ No of bales _____
Alpha-acid (%) _____ Whole cones (%) _____
Beta-acid (%) _____ Seeds (%) _____
Oil (mls/100g) _____ Leaf and stem (%) _____
Moisture _____

NITROGEN FERTILITY AND PLANT SPACING STUDY

(Conducted by C. E. Nelson)

This study was initiated by Mr. C. E. Nelson, Washington State University Agronomist, in March to determine the effect of certain management practices on yield. The study will become the responsibility of the Hop and Mint Investigations in 1971 because of Mr. Nelson's retirement.

Certain brewers and market specialists have encouraged the domestic production of continental-type hops presently imported from Europe. In 1958, Dr. S. N. Brooks initiated a study to determine the effect of trellis height on the production of Hallertau in Oregon. It has been observed in various trials that continental-type hops are less vigorous and produce smaller floral branches with fewer cones than high yielding varieties such as Cluster. Closer spacing of continental-type hops appeared to be a logical approach along with various levels of nitrogen which previously have been shown to affect both yield and alpha content.

Mr. Nelson selected three continental-type varieties, namely Northern Brewer, Fuggle-N selection from Wye College, England which was heat treated for virus by Dr. C. B. Skotland, and experimental variety 56013. The main plots consisted of four rows, two spaced at 3.5' x 7' and the other spaced at the normal 7' x 7'. Main plots were subdivided into seven nitrogen level treatments. Three replicates were used in the study.

Experimental 56013 produced the highest yield. Yield of Fuggle and 56013 was increased by one bale with close spacing (table 1).

Yields of the three varieties increased with N levels, though 56013 demonstrated a rapid growth with the first increment of N (table 2).

Alpha-acid content was not affected by spacing and only slightly by nitrogen (table 3).

Oil contents listed in table 4 as a matter of record.

Table 1. Effects of plant spacing on first-year planted hop varieties. Values are averages of 7 nitrogen level treatments.

Variety	Plant spacing 7 x 7 ft	7 x 3.5 ft	Variety average	Date of bloom
	----------Bales per acre[1/] -------			
USDA 56013	4.27	5.49	4.88	7/15
Fuggle	2.56	3.78	3.17	7/14
Northern Brewer	1.64	2.36	2.00	7/18
Average	2.82	3.88		

1/ 200-lb bales, 8% moisture

L.S.D. (5%) Varieties 0.56, Spacing 0.46, no interaction

C. V. 18.8%

Table 2. N level effect on three first-year planted hop varieties. Values are averages of two plant spacing treatments

Soil NO_3-N plus fertilizer	Variety USDA 56013	Fuggle	Northern Brewer	Average
lb/a	----------Bales per acre[1/]----------			
50	2.80	2.30	0.95	2.02
75	4.86	2.91	1.46	3.08
100	4.65	3.34	1.76	3.25
150	5.34	3.47	2.05	3.62
225	4.82	3.37	2.11	3.43
450	5.56	3.10	2.87	3.84
650	6.16	3.70	2.80	4.22
Average	4.88	3.17	2.00	

1/ 200-lb bales, 8% moisture

L.S.D. (5%) Varieties 0.56, N level 0.42, N level x Var. 0.71

C.V. 18.8%

Table 3. Alpha acid in hop cones from the N level and spacing treatments for three varieties. Values are averages of three replicates.

N level	7 x 7 ft spacing			7 x 3.5 spacing			N level avg
	Northern Brewer	Fuggle	USDA 56013	Northern Brewer	Fuggle	USDA 56013	
	Per cent						
50	9.48	7.40	6.29	10.64	7.68	6.67	8.02
75	10.06	7.57	7.24	10.26	7.50	7.87	8.41
100	10.21	7.79	6.44	9.51	7.79	6.98	8.12
150	9.59	7.19	6.78	10.26	7.76	7.44	8.17
225	10.14	7.44	6.02	9.18	7.37	6.47	7.77
450	9.06	7.05	7.00	9.96	7.17	7.09	7.89
650	9.30	7.25	6.39	9.61	7.26	6.54	7.72
Average	9.69	7.38	6.59	9.92	7.50	7.00	

L.S.D. (5%) Varieties 0.78, N level 0.41, spacing N.S., no interactions
C.V. 7.68%

Table 4. Oil content of hop cones from the N level treatments by varieties. Data are from the 7 x 7 ft spacing treatment only.

N level lb/a	Northern Brewer	Fuggle	USDA 56013
	Per cent		
50	1.06	1.59	0.87
75	0.97	1.31	1.34
100	1.21	1.65	1.16
150	1.20	1.65	1.38
225	1.40	1.52	0.97
450	1.19	1.34	1.10
650	1.23	1.55	1.29
Average	1.18	1.52	1.16

Analytical data for this study were obtained by Mr. Robert Early and Alan Mortensen, Washington State University technicians at IAREC.

ROLE OF PHENOL METABOLISM IN A VIRUS DISEASE OF HOPS

(Conducted by Hassan Melouk)

Hop varieties which carry PNRSV usually display symptoms when warm growing conditions are followed by cooler temperatures. Early symptoms include line pattern, mottling, and vein clearing followed by necrosis in susceptible varieties and a gradual disappearance of symptoms in tolerant varieties.

Our cooperation was with Dr. Skotland, through an ARS Grant, and Dr. Melouk who established biochemical tests for determining the susceptibility or tolerance of a hop variety to PNRSV.

Experimental varieties 56013 and 62013 were evaluated for virus by Dr. Melouk and compared with Early Prolific, a virus susceptible variety.

Peroxidase activity in the hop varieties Early Prolific and 56013, 1970[1/]

	PEROXIDASE ACTIVITY					
	No. days plants grown 27-30C			No days plants grown 18-20C		
Hop variety	4	8	12	5	8	12
Early Prolific	0.24	0.31	0.25	0.39	0.39	0.39
56013	0.13	0.12	0.12	0.15	0.15	0.09

Note: Plants were grown at 27-30C for 12 days, then transfered to 18-20C for 12 days.

Peroxidase activity in the hop varieties Early Prolific and 62013, 1970[1/]

	Peroxidase activity in leaves from plants at different ages (days)			
Variety	25	30	37	44
Early Prolific	0.29	0.29	0.34	0.36
62013	0.11	0.11	0.19	0.14

1/ Peroxidase activity is expressed as change in optical density at 470 mμ of 5 ml substrate mixture, between 30 and 90 seconds after adding 0.1 ml of enzyme preparation. Substrate mixture consisted of 50 ml of 0.02% guaiacol solution in 0.02 M phosphate buffer (pH 6.0) and 1 ml of 0.02% H_2O_2 solution. Average of 4 replicates.

Total phenolic content in hop varieties "Early Prolific" and 56013, 1970[2/]

	TOTAL PHENOLIC CONTENT					
	No. days plants grown 27-30C			No. days plants grown 18-20C		
Hop variety	4	8	12	5	8	12
Early Prolific	2.60	2.65	2.12	2.85	2.84	2.82
56013	3.73	3.54	3.13	4.00	4.18	5.35

Note: Plants were grown at 27-30C for 12 days, then transferred to 18-20C for 12 days.

Total phenolic content in the hop varieties "Early Prolific" and 62013, 1970[2/]

	Total phenolic content in leaves from plants at different ages (days)			
Variety	25	30	37	44
Early Prolific	3.70	4.85	5.37	5.94
62013	3.26	5.60	6.79	7.73

2/ Total phenolic content is expressed as mg of gallic acid/g of fresh weight tissue. Average of 4 replicates.

PNRSV was mechanically transmitted from 56013 to cucumber, but the mechanical transfer from 62013 was unsuccessful.

Varieties 56013 and 62013 have a higher total phenolic content and a lower peroxidase level than Early Prolific. Polyphenol oxidase activity noted in Early Prolific was not noted in either 56013 or 62013. The metabolic changes associated with a warm-cool temperature regime coincides with PNRSV expression on the hop leaves and an increase in peroxidase activity and total phenols.

These biochemical comparisons indicate that 56013 and 62013 react to PNRSV as tolerant varieties.

STUDY OF THE INHERITANCE OF YIELD OF FLOWERS, MATURITY AND ALPHA CONTENT IN BOTH MALE AND FEMALE HOPS

In 1967, Dr. S. N. Brooks established a yield segregation study at Corvallis to determine the yield of dry matter in both male and female hops. This study included three male and three female parents and the nine progenies from reciprocal crosses. A more detail description is reported in the 1967 Annual Report of Hop and Mint Investigations under the heading "Dry matter development in male and female hops". Dr. Brooks planned to compare the performances of the progenies of a clone with that of the clone when a) both were grown under widely different fertility levels and b) when one parent was changed.

Dr. Haunold abandoned the study in 1968. One replication of the study was retained in 1969 for a lupulin study by myself and Mr. S. T. Likens. As the season progressed it became evident that additional data could be obtained as a preliminary for a planned inheritance study proposed to the U. S. Brewers Association by Dr. Haunold

An average of five male and five female plants from each of the nine progeny, plus the parents were used to obtain data on number of floral structures, branching pattern of floral units, maturity, and lupulin analysis.

Lupulin analyses were obtained by Mr. S. T. Likens and Miss G. B. Nickerson and reported in the 1969 Annual Report of Hop and Mint Investigations Appendix under the heading SY Male and Female Lupulin Analyses. Flower number and branching patterns were obtained from two flowering laterals collected at the eight-foot level of each plant.

The following parents were used in the study:

Female	Fuggle
	Hallertauer
	19105 (3/8 Fuggle, 1/4 Late Grape, 3/8 X)
Male	19058M (1/2 Early Green, 1/2 X)
	19170M (1/4 East Kent Golding, 1/8 Early Green, 1/16 Kent Golding, 9/16 X)
	19173M (1/2 Stiesselspalt, 1/4 Late Cluster, 1/4 X)

A strong European origin is evident in the pedigrees of both male and female parents.

INHERITANCE EVALUATION OF FLOWER NUMBER, BRANCHING TYPE, LUPULIN, AND MATURITY OF HOP PROGENIES RESULTING FROM RECIPROCAL CROSSES

Table 1. Number of floral structures[1/] located at the second node of hop laterals. Values for parents in parentheses.

Parents ♀ \ ♂	19170 (4)	19058 (20)	19173 (25)
	Female Progeny		
Hallertau (3)	3	4	3
Fuggle (5)	5	9	12
19105 (10)	2	9	11
	Male Progeny		
Hallertau (3)	11	10	20
Fuggle (5)	5	17	30
19105 (10)	11	18	20

1/ Terminal male flower clusters, usually consisting of 5 to 10 individual flowers, or strobiles.

Table 2. Number of floral structures on one flowering lateral. Values for parents are in parentheses.

Parents ♀ \ ♂	19170 (25)	19058 (150 est)	19173 (180)
	Female Progeny		
Hallertau (25)	20	20	15
Fuggle (35)	20	50	60
19105 (45)	25	70	50
	Male Progeny		
Hallertau (25)	90	50	110
Fuggle (35)	40	145	210
19105 (45)	50	110	110

It would appear that it is difficult to have Hallertau progeny with an increased number of inflorescences. This in fact has been demonstrated with several years of crossing on Hallertau resulting in selections with good quality, good disease resistance, but with poor yields (less than 7 bale per acre), such as experimental lines 63004, 64005, 65031, 6517-46, and 6517-47. The Hallertau variety produces approximately 3,000 to 4,000 cones per plant (4 vines) which weigh 100 milligrams each grown seedless. This represents three-fourths pound of dry hops per hill or 700 pounds per acre, spaced 7' x 7'.

Fuggle produce approximately 5,000 cones per plant, but progeny resulting from male parents 19058M and 19173M exceeded Fuggle cone number by 50% (Table 2). Our breeding program has not made many crosses on Fuggle to support this point, though experimental 63002 was one example of Fuggle progeny which had 50% more cones than its female parent.

Female genotype 19105 represents a line with excellent floral branching resulting in 8 to 10 thousand cones per plant. Male line 19170M reduced the cone number of 19105 progeny as it did with Fuggle and Hallertau progeny. This male displays very poor vigor and branching pattern, sustaining its continuence in the program as germplasm for earliness.

The genetic potential of female parent 19105 for flower number was displayed in progenies resulting from male lines 19058M and 19173M. This strongly inheritable factor of 19105 is also apparent in progeny selections 6803 (pages 19-20). Accession numbers 64001, 64002, and 64003 represent selection of 19105 x 19173M progeny; likewise, 64007 experimental hop resulted from a 19105 x 19058M cross. Genotype 64001 was discontinued in the program due to late maturity, but 64002, 64003, and 64007 were established in a seedless observation plot in Oregon and yielded 10 to 14 pounds of green hops per hill as a "baby".

Genotype 19105 is an excellent female parent in breeding for yield, (flower number) which is related to the branching pattern of the floral structures (Table 4).

Table 3. Maturity[1/] of flower structures as indicated by a ripe strobile or dehiscing anther. Values for parents in parentheses.

Parents ♀ \ ♂	19170 (1)	19173 (2)	19058 (3)
	Female Progeny		
Hallertau (1.5)	2.5	2.5	2.5
Fuggle (2.5)	1.5	3.0	3.0
19105 (3.5)	2.0	3.0	3.5
	Male Progeny		
Hallertau (1.5)	2.0	2.5	1.0
Fuggle (2.5)	1.5	2.0	2.0
19105 (3.5)	2.0	2.5	2.5

1/ Early maturity, Aug. 20-31; medium maturity, Sept. 1-10; and late maturity after Sept. 10; were assigned values of 1, 2, and 3 respectively.

Table 4. Branching type[1/] of floral structures located at the second node of hop laterals. Values for parents in parentheses.

Parents ♀ \ ♂	19170 (P)	19058 (S)	19173 (T)
	Female Progeny		
Hallertau (P)	P	P	P
Fuggle (S)	P	S	S-T
19105 (T)	P	S	S
	Male Progeny		
Hallertau (P)	P-S	S	S-T
Fuggle (S)	P	T	T
19105 (T)	P-S	S	S-T

1/ Noted as primary, secondary and tertiary branching patterns.

One disadvantage of 19105 as a parent is late maturation. Data in Table 3 indicate that the maturity of progeny from Fuggle and 19105 is influenced by the maturity of the male parent. The same effect of male parents was noted with the branching patterns of progeny from 19105 and Fuggle (Table 4).

The following data was obtained by Dr. S. N. Brooks in the "baby" year and illustrates some of the same heritability factors noted in our study in 1969.

Pounds of dry-matter, at maturity, per hop hill including vine, leaves, and flowers, 1967. Values for parents in parentheses.

Parents

♀ \ ♂	19170 (10.9) P	19173 (10.9) S	19058 (12.6) T
	Female Progeny		
Hallertau (10.8) P	11.3	9.9	11.4
Fuggle (10.3) S	8.7	10.0	12.2
19105 (13.0) T	12.7	12.1	14.2

Dry-matter data are comparable to yield or flower number listed in Tables 1 and 2.

Maturity dates obtained by Dr. Brooks in 1967 were defined as the date of initial cone development for the female parents and the date of maximum pollen-shed for male parents. Harvest dates listed for the respective progenies are as follows:

Parents

♀ \ ♂	19170 (28 Jul)	19173 (7 Aug)	19058 (11 Aug)
	Female Progeny		
Hallertau (29 Jul)	1 Sep	8 Sep	15 Sep
Fuggle (31 Jul)	28 Aug	1 Sep	11 Sep
19105 (11 Aug)	8 Sep	15 Sep	18 Sep

Another disadvantage of 19105 as a parent for varietal development is the low α-acid content of lupulin which results in a low alpha percentage in the dried hops. The data in Tables 5 and 6 fails to show the inheritance of α-acid

Table 5. Alpha-acid percentages of lupulin. Value of parents in parentheses.

Parents ♀ \ ♂	19170 (29)	19058 (26)	19173 (27)
	Female Progeny		
Hallertau (34)	30	37	37
Fuggle (44)	35	42	49
19105 (6)	25	24	25
	Male Progeny		
Hallertau (34)	25	25	31
Fuggle (44)	27	39	33
19105 (6)	27	16	13

Table 6. Alpha-Beta ratios of lupulin. Values for parents in parentheses.

Parents ♀ \ ♂	19170 (0.65)	19058 (0.53)	19173 (0.61)
	Female Progeny		
Hallertau (1.23)	0.75	1.37	1.15
Fuggle (2.02)	1.14	1.28	2.52
19105 (0.14)	0.58	0.55	0.59
	Male Progeny		
Hallertau (1.23)	0.84	0.59	0.94
Fuggle (2.02)	0.68	1.10	1.18
19105 (0.14)	0.63	0.33	0.28

as demonstrated in Dr. Haunold's genetic study of alpha-acid inheritance reported in the 1969 Annual Report of Hop and Mint Investigations under the Hop Chemistry section.

The α-acid in lupulin ranges from 5 to 60 % in male and female germplasm. In this study, the male parents had lupulin with approximately 25% α-acid and the female parents ranged from 6 to 44% α-acid in lupulin. Female progeny data in Table 5 show that the alpha content of female hops is limited to the upper level of parentage.

PHENOTYPIC EVALUATION OF MALE LINES AS POTENTIAL STOCK

The important role of the male parent in the inheritance of yield and chemical factors was reported by Brooks, S. N. and S. T. Likens, Variability of morphological and chemical quality characters in flowers of male hops. Crop Sci. 2:189-192. 1962., and verified by recent studies on a) Crosses for high analysis, b) Inheritance for alpha-acid, and c) Segregation for yield. Until recently, male lines have not been evaluated, selected or developed through a breeding program.

During 1969-1970 with the efforts of Mr. S. T. Likens and Miss G. B. Nickerson, thirty-eight male lines were evaluated for their physical and chemical properties to determine genetic potential in breeding.

The importance of tertiary branching patterns on flowering laterals is common knowledge and recognized by the industry as clustering. The "Cluster" variety was so-called because of the tertiary branching and 3-forked clusters. Inheritance of branching patterns was demonstrated in the segregation for yield study reported earlier in this report.

Length of flowering lateral, branching pattern, and floral density are probably the three main criteria for evaluating the yielding potential of male hops for breeding purposes. These evaluations can be obtained in the field during the months of June and July when plants are in the bud stage or during and after pollen shedding.

Floral density of male parents may be related to terminal clustering of female inflorescences. The relationship of lateral length and branching pattern between parent and progeny is obvious. Branching patterns should be evaluated with regards to the lengths of primary and secondary clusters. A tertiary branching type with a short primary cluster would be of little value for breeding. Lengths of primary clusters ranged from 3 to 12 inches and secondary clusters from 1 to 4 inches in length. Genotypes such as 19058, 19173, 19182, 64035, and 6322-01 would be considered as having very good breeding potential for yield.

Selection of superior male lines for breeding also involves an agronomic evaluation such as maturity, growth habit, and disease reaction. Additional emphasis on the production of alpha-acid per acre necessitates analytical information on lupulin glands located in the flowers of male lines. This phase of work was published by Brooks and Likens in 1962. The following tables summarize the analytical data obtained by Mr. Likens and Miss Nickerson on the 38 male lines previously evaluated for their yielding potential.

Genetic potential is a rating based on the overall lupulin and floral evaluations, plus maturity and disease information. As with floral density in the male, the number of glands per anther may be related to the gland number on the female inflorescence. Refer to Mr. Likens section on Lupulin Quality in the 1970 Annual Report of Hop and Mint Investigations at Corvallis for further discussion.

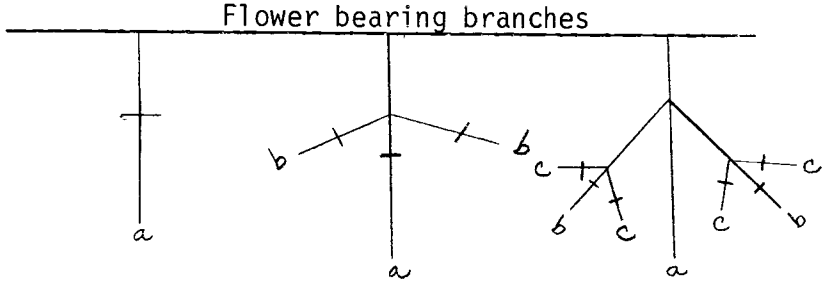
Evaluation of male hop genotypes for yielding potential, 1970

(Data obtained from flower-bearing branches located at the second node of a flowering lateral)

Accession #	Pedigree	1/ Primary Cluster				2/ Secondary Cluster			3/ Evaluation	
		(in) lng	(#) nodes	2 base internode lng (in)	node type	(in) lng	Pattern	Tertiary type	Floral density	Overall
19005	1/2 LC, 1/2 X	5	3-6	2	Alt	1	2-fork-opp	-	M	M
19006	Unknown	8	3-6	4	Alt	3	3-fork-alt	x	M	G
19007	1/2 BRS F, 1/2 X	5	0-3	2	Alt	1	3-fork-alt	x	P	P
19008	1/4 SEM, 3/4 X	4	0-3	1	Alt	1	3-fork-opp	-	M	M
19009	3/4 F, 1/4 X	6	3-6	3	Alt	1	2-fork-opp	-	P	P
19036	1/2 LC, 1/4 F, 1/4 X	4	0-3	1	Alt	1	3-fork-opp	-	G	M
19037	1/2 F, 1/2 X	4	3-6	2	Alt	2	2-fork-opp	x	M	M
19046	1/4 LC, 1/4 F, 1/2 X	5	3-6	2	Alt	1	2-fork-opp	-	M	M
19058	1/2 EG, 1/2 X	10	3-6	4	Alt	4	3-fork-opp	x	G	VG
19061	1/2 LG, 1/4 F, 1/4 X	4	3-6	1	Alt	1	single	-	P	P
19170	1/4 EKG, 1/8 EG, 1/16 KG, 9/16 X	2	0-3	-	Alt	0	-----	-	M	P
19173	1/2 STSP, 1/4 LC, 1/4 X	8	3-6	3	Opp	3	3-fork-opp	-	G	G
19182	1/2 BUL, 3/8 BEL, 1/8 X	12	3-6	4	Opp	2	single	-	M	G
51060	1/4 LG, 1/8 F, 1/8 LC, 1/8 VERT, 3/8 X	4	3-6	1	Alt	2	2-fork-opp	-	P	M
51114	1/8 LAN, 1/8 GC, 1/8 SEM, 1/16 F, 9/16 X	5	3-6	1	Alt	2	3-fork-opp	-	G	G
52040	1/16 LAN, 1/16 RV, 1/16 SEM, 13/16 X	5	3-6	2	Alt	2	3-fork-opp	-	M	G
52045	3/8 EG, 1/4 EKG, 1/16 KG, 5/16 X	6	3-6	2	Alt	2	3-fork-opp	x	G	G
52048	1/4 LC, 1/16 F, 1/16 RV, 5/8 X	6	3-6	2	Alt	2	3-fork-opp	x	G	MG
63011	1/4 LG, 1/4 EG, 1/8 F, 3/8 X	4	3-6	2	Alt	2	3-fork-opp	-	M	M
63012	1/2 BG, 1/2 UT-WA	5	3-6	2	Alt	2	3-fork-opp	-	G	G
63014	1/2 BG, 1/2 UT-WA	10	3-6	4	Alt	2	2-fork-opp	x	M	M
63015	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	5	3-6	1	Alt	2	2-fork-opp	-	M	M
63016	1/2 BG, 1/2 UT-WA	6	3-6	2	Alt	2	3-fork-opp	-	P	MP

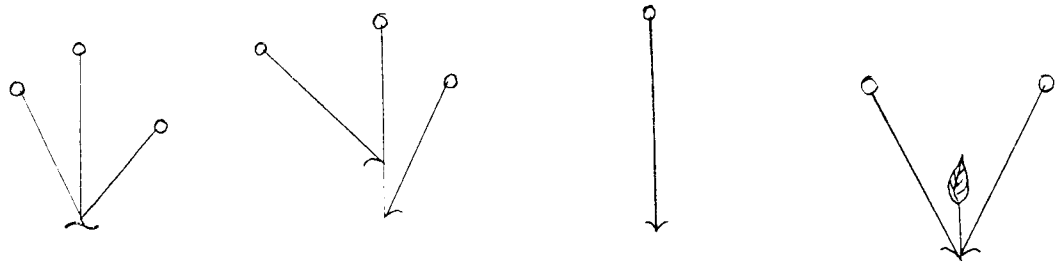
Accession #	Pedigree	1/ Primary Cluster (in) lng	(#) nodes	2 base internode lng (in)	node type	2/ Secondary Cluster (in) lng	Pattern	Tertiary type	3/ Evaluation Floral density	Overall
63017	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	3	0-3	-	Opp	0	-----	-	P	P
63034	1/2 BG, 1/2 UT-WA	6	>6	3	Opp	2	2-fork-opp	x	VP	P
6322-01	1/4 STSP, 3/16 F, 1/8 LC, 1/8 LG, 5/16 X	8	3-6	3	Alt	3	3-fork-alt	x	G	VG
64027	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	4	0-3	2	Alt	1	single	-	P	P
64028	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	5	3-6	1	Alt	2	3-fork-opp	-	M	G
64029	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	4	0-3	1	Alt	1	3-fork-opp	-	P	P
64031	3/4 BG, 1/8 EKG, 1/16 BAV, 1/16 X	2	0-3	2	Alt	1	2-fork-alt	-	M	P
64035	1/2 ZAT 7K491, 1/2 X	12	> 6	4	Alt	3	3-fork-opp	x	G	VG
64036	1/2 ZAT 7K491, 1/2 X	4	0-3	2	Alt	1	2-fork-alt	-	M	M
64101	PI 302775	5	0-3	2	Alt	2	2-fork-opp	-	M	MP
64102	PI 302776	2	0-3	-	Alt	0	-----	-	G	P
64104	PI 302778-Wye	4	0-3	2	Alt	2	3-fork-opp	-	M	M
65035	3/4 HA, 3/16 F, 1/16 X	6	3-6	1	Alt	2	3-fork-opp	-	G	G
65037	3/4 HA, 3/16 F, 1/16 X	6	3-6	2	Alt	3	2-fork-opp	x	M	MG
6708-14	1/2 LC, 1/4 BG, 1/4 UT-WA	6	3-6	2	Alt	3	3-fork-alt	-	G	VG

1/ The length of the two proximal internodes provides a measure of flower density on the main axis.



a)Primary cluster
b)Secondary cluster
c) Tertiary cluster

2/



(a) (b) (c) (d)

a) 3-fork opposite
b) 3-fork alternate
c) single branching
d) 2-fork opposite

3/ Floral density is an evaluation of the number of flowers located at the distal end of a cluster. Less than five flowers was rated as poor. The over-all evaluation considers the entire male floral morphology and provides a rating to predict the inheritance of an individual male to produce high yielding female progeny.

Chemical and Physical Evaluation of Male Genotypes for Determining Genetic Potential

Genotype Acc. #		Av. no. glands/ anther	Lupulin Analysis %α	%β	α/β	Storage	Evaluation[1] Lupulin	Floral	Maturity	Disease[2]	Genetic Potential
19005	'69	---	10	57	0.2						
	'70	7.1	10	64	0.2						
	AV.	---	10	60	0.2	P	P*	M	L	++	P*
19006	'69	---	16	52	0.3						
	'70	9.4	16	44	0.4						
	AV.	---	16	48	0.3	P	P	G	M	+++	M
19007	'69	---	16	34	0.5						
	'70	7.1	20	51	0.4						
	AV.	---	18	42	0.4	P	P	P	L	++	P
19008	'69	---	40	23	1.8						
	'70	7.1	45	27	1.7						
	AV.	---	42	27	1.7	G	MG	M	E	--	MG
19009	'69	---	19	52	0.4						
	'70	7.8	27	57	0.5						
	AV.	---	23	54	0.4	P	P	P	E	--	P
19036	'69	---	13	64	0.2						
	'70	8.2	19	56	0.3						
	AV.	---	16	60	0.3	P	P*	M	E	+	MP*
19037	'69	---	23	50	0.5						
	'70	7.7	24	50	0.5						
	AV.	---	23	50	0.5	P	P	M	M	+	M
19046	'69	---	9	62	0.1						
	'70	7.2	22	51	0.6						
	AV.	---	16	56	0.3	P	P	M	M	+	M

19058	'69	---	33	49	0.7					
	'70	9.0	30	47	0.6					
	AV.	---	32	48	0.7	MG	M	VG	M	++	MG
19061	'69	---	12	61	0.2					
	'70	7.1	22	48	0.5					
	AV.	---	17	54	0.3	P	P	P	M	+	P
19170	'69	---	36	40	0.9					
	'70	---	--	--	--					
	AV.	---	--	--	--	--	P	P	VE	+	P
19173	'69	---	24	46	0.6					
	'70	---	--	--	--					
	AV.	---	--	--	--	--	P	G	M	+	M
19182	'69	---	42	23	1.8					
	'70	5.6	44	21	2.1					
	AV.	---	42	22	1.9	G	G	G	L	++	G
51060	'69	---	9	61	0.2					
	'70	9.3	22	50	0.6					
	AV.	---	16	56	0.3	P	P	M	M	+	M
51114	'69	---	18	50	0.4					
	'70	4.0	27	44	0.6					
	AV.	---	22	47	0.5	G	P	G	M	++	M
52040	'69	---	23	51	0.5					
	'70	7.7	9	66	0.1					
	AV.	---	16	59	0.3	P	P	G	M	+	M
52045	'69	---	19	29	0.6					
	'70	3.1	30	43	0.7					
	AV.	---	20	36	0.6	MG	MP	G	M	+++	M
52048	'69	---	14	40	0.4					
	'70	6.8	27	46	0.6					
	AV.	---	20	43	0.5	P	P	MG	E	++	M

63011	'69	---	17	43	0.4						
	'70	6.7	29	49	0.6						
	AV.	---	23	46	0.5	M	P	M	E	+	MP
63012	'69	---	54	24	2.2						
	'70	10.2	57	23	2.4						
	AV.	---	56	24	2.3	G	G	G	E	++	G
63014	'69	---	63	17	3.7						
	'70	13.5	58	20	2.9						
	AV.	---	60	18	3.3	G	VG	M	M	++	MG
63015	'69	---	54	22	2.4						
	'70	6.2	53	25	2.1						
	AV.	---	54	24	2.2	G	G	M	M	++	MG
63016	'69	---	51	23	2.2						
	'70	11.1	56	24	2.3						
	AV.	---	54	24	2.2	G	G	MP	E	+++	M
63017	'69	---	46	29	1.6						
	'70	7.6	49	25	2.0						
	AV.	---	48	27	1.8	G	G	P	E	++	M
63034	'69	---	46	28	1.6						
	'70	11.2	44	24	1.7						
	AV.	---	45	26	1.7	MG	MG	P	-	+	M
6322-01											
	'69	---	13	35	0.4						
	'70	2.6	16	11	1.5						
	AV.	---	14	23	0.6	P	VP	VG	M	-	P
64027	'69	---	55	28	2.0						
	'70	12.8	50	29	1.7						
	AV.	---	52	28	1.9	G	G	P	-	+	M
64028	'69	---	51	25	2.0						
	'70	6.2	48	24	2.0						
	AV.	---	50	24	2.1	G	G	G	M	+	G

64029	'69	---	47	31	1.5					
	'70	8.0	42	35	1.2					
	AV.	---	44	33	1.3	G	MG	P	M	++	M
64031	'69	---	50	30	1.7					
	'70	6.6	44	34	1.3					
	AV.	---	47	32	1.5	G	MG	P	-	+	M
64035	'69	---	57	24	2.4					
	'70	6.0	46	24	1.9					
	AV.	---	52	24	2.2	G	G	VG	M	+	G
64036	'69	---	49	26	1.9					
	'70	5.9	27	48	0.6					
	AV.	---	38	37	1.0	G	M	M	M	+	M
64101	'69	---	48	23	2.1					
	'70	6.6	43	27	1.6					
	AV.	---	46	25	1.8	G	MG	MP	VE	+	M
64102	'69	---	49	31	1.6					
	'70	6.4	34	31	1.1					
	AV.	---	42	31	1.4	M	M	P	VE	+	M
64104	'69	---	43	17	2.5					
	'70	5.1	37	17	2.2					
	AV.	---	40	17	2.3	G	M	M	VE	++	MG
65035	'69	---	32	25	1.2					
	'70	6.9	33	38	0.8					
	AV.	---	32	32	1.0	M	MP	G	M	+	M
65037	'69	---	46	28	1.6					
	'70	8.4	48	28	1.7					
	AV.	---	46	28	1.6	MG	M	MG	-	+++	M

6708-14	'69	---	---	---	---							
	'70	8.6	---	---	---							
	AV.	---	---	---	---	M	-	VG	-	-	-	

1/ Lupulin evaluation of poor, medium or good was based on lupulin gland number, analysis, and storage. High alpha was considered to be favorable over high beta. An asterisk (*) indicated a high beta which could be desirable and evaluated higher.

Floral evaluation was obtained from Table - Evaluation of male hop genotypes for yielding potential, 1970.

2/ Evaluation determined by severity of virus expression and/or downy mildew infection.